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DEPARTMENT OF THE INTERIOR,

CENSUS OFFICE.

FRANCIS A. WALKER, Superintendent,
Appointed April 1, 1879; resigned November 3, 1881.

CHAS. W. SEATON, Superintendent,
Appointed November 4, 1881. Office of Superintendent abolished March 3, 1885.

STATISTICS AND TECHNOLOGY

OF THE

PRECIOUS METALS.

PREPARED UNDER THE DIRECTION

OF

CLARENCE KING,

SPECIAL AGENT,

BY

S. F. EMMONS AND G. F. BECKER.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
SECRETARY'S OFFICE,
Washington, June 1, 1885.

Hon. L. Q. C. LAMAR,
Secretary of the Interior.

SIR: I have the honor to transmit herewith the Report on the Statistics and Technology of the Precious Metals, prepared under the direction of Hon. Clarence King, formerly Director of the United States Geological Survey.

This report forms the thirteenth volume of the series constituting the final report on the Tenth Census.

Very respectfully, your obedient servant,

JAMES H. WARDLE,
Chief of Census Division.

TABLE OF CONTENTS.

	Page.
LETTER OF TRANSMITTAL	v
INTRODUCTORY REMARKS	vii-xiv
PREFACE	1-3
CHAPTER I.—Geological sketch of the states and territories of the Pacific division	5-59
II.—Geological sketch of the states and territories of the Rocky Mountain division	60-104
III.—Deep mines	105-177
IV.—Placer mines and mining ditches	178-241
V.—Amalgamating mills	242-285
VI.—Smelting works	286-295
VII.—Bullion production	296-382
VIII.—Mints	383-402
APPENDIX I.—Mining industries of Utah	403-489
II.—Schedules	491-508
III.—Directory of mines and works	509-532
INDEX	533-541

LETTER OF TRANSMITTAL.

NEW YORK, *February* 8, 1883.

Hon. C. W. SEATON,
Superintendent of Census.

SIR: I have the honor to transmit the accompanying report on the technology and statistics of the precious-metal industries by Mr. S. F. Emmons and myself. The investigation which forms the subject of this volume was committed to our charge early in 1880 by the Hon. Clarence King, my predecessor, as special agent in charge of the investigation of the precious-metal industries. Mr. King retained this position till May 1, 1882, a year after the completion of the field-work, when he was compelled by ill-health to resign it, and you appointed me to fulfill the very simple duties remaining to be discharged. While appreciating the honor done me, I beg leave to draw your attention to the fact that the direction of the inquiry was in Mr. King's hands until all the more important questions were settled, and that the credit of the general conduct of the work belongs entirely to him. The part taken by Mr. Emmons and myself in the investigation is sufficiently explained in the preface.

Very respectfully, your obedient servant,

GEORGE F. BECKER,
Special Agent.

INTRODUCTORY REMARKS.

By CLARENCE KING.

PECULIAR CONDITIONS AFFECTING AMERICAN MINING.—Ever since the inception of mining on a large scale and permanent basis in the United States, comparisons have been made between the methods practiced here and those in vogue in European countries, and the conclusions have naturally been at variance. The subject has been discussed by foreign engineers who have traveled in this country, and who have usually looked at the subject from the standpoint of European conditions. To them many of our methods have appeared crude, and they have been apt to condemn the apparent want of the economy and thoroughness which are so marked characteristics of the best foreign practice. American engineers who have received the earlier portion of their technical training abroad have also been prone to criticize many of our mining methods. A longer acquaintance with the conditions which prevail here has usually modified such views. It may not be out of place to note a few of the salient differences in methods prevailing in this country as compared with those abroad.

Among the best characteristics of American mining practice may be mentioned the originality and ingenuity of the methods which have been adopted. In many cases, as for example the system of hydraulic mining, a completely new departure has been made and within a short time carried to an extreme point of development. In other instances, modifications and improvements on foreign methods have been added to such an extent that their sources are scarcely recognizable. Another striking feature is the rapidity of execution and the consequent saving of time and interest. It is true that this has often been pushed too far, and in many instances better results might have been secured by more conservative methods. But it may be said, as a rule, that capital invested in precious-metal mines in this country has always secured quick returns, if any. This is necessitated by the demands of investors, who are seldom satisfied, when interested in precious-metal mining, with the plodding methods which perhaps in the long run would be more profitable, and on which they would rely in any other branch of industry. Although undue haste must be condemned from an economic point of view, the spur has not been without its advantages on the technical side.

Still another feature is the boldness of conception of engineering enterprises connected with mining, and the large scale on which operations are conducted. As examples: The ditch, flume, and pipe system of the hydraulic mines; the daring feats in railroad engineering, securing transportation to and from rugged mining districts; the extensive tunnel enterprises, and the deep shafts fitted with heavy hoisting and pumping machinery.

On the other hand, it must be acknowledged that the attempt to rely on originality of plan to the exclusion of experience gained abroad has often resulted in failure. Novel processes and machinery which have been tried and condemned by foreign miners have sometimes been reinvented and experimented upon in this country with a failure which would have been avoided had the records of foreign mining been consulted. The desire for immediate returns has been carried to an extreme and has entailed unnecessary loss. To open mines rapidly usually requires a greater outlay than where work is prosecuted at a slower rate. Mines are often worked on three shifts a day when two would be better. In districts remote from railroad communications freight is often hauled out of season at vastly increased expense, when the more economical plan would be to close down the works temporarily. Ores are treated at high cost and at a low percentage of metals saved in primitive mills and smelters, when such delay as would be caused by the erection of custom works or the approach of railroads would much more than offset the loss of interest on unreduced ores. It should be noted, however, that mines worked without capital or with insufficient capital are obliged to adopt the hand-to-mouth system in order to keep in operation at all.

Foreign engineers have frequently remarked on the apparent recklessness in regard to small savings manifested at many of our mines. Another point, which is equally patent to American miners, is the planning and construction of expensive works at mines whose development is insufficient to authorize them. Reduction works have often been erected before the character of the ore to be treated has been fully determined; thus mines not explored below the

water level, but which show free-milling ores at or near the surface, have been equipped with wet-crushing mills, necessitating extensive changes in plant after the surface ores have been exhausted, and amalgamating mills have been built where a small leaching plant would have been more suitable; and sometimes reduction works have been built for mines entirely undeveloped.

Investors in mining property seem always to have preferred taking great chances to smaller but safer investments. This trait has been so marked that a few years ago it seemed easier to place a mine on the market for a million dollars than to sell the same mine at say one-tenth of that price. Mining properties thus capitalized at high figures are apt to be equipped with over-heavy plant.

There has, perhaps, been too much willingness to experiment with novel devices, especially with untried ore-reducing machinery. This tendency has been more particularly shown in the case of mines controlled by owners at a distance and living in those portions of the country where mining is an unknown art. Mine owners who live in the mining regions are not so apt to make mistakes of this kind.

Two apparently contradictory traits have been manifested by some of our "practical" miners; on the one hand, they sometimes trust too much to rule-of-thumb, and, on the other, are sometimes deceived by self-styled "scientific" men, who profess an occult knowledge of mining matters to which trained engineers would make no claim.

To the American miner the leading characteristics of foreign methods are economy as to details of expense and in minute metallurgical savings. The latter are exemplified by the complex systems of treating mixed ores as practiced in some of the German works and at Swansea, where there are no waste products, and where regenerative methods are so largely adopted. Our larger establishments are tending more and more to this system of working and are paying more attention to the treatment of residues.

In some foreign countries the mining industry possesses a stability and steadiness which results largely from government ownership and supervision; and these causes, however inapplicable in this country, have certainly had an economic effect. When such is the case, a far-sighted policy is always shown; plans are laid with a view to the remote future, and the plant and mine openings are substantial to a degree seldom seen here. The American miner, expecting to work out his mine in a few years, would hardly think of using brick-work or masonry in his galleries, etc., as is done in some of the foreign mines. Where an investment is made with the expectation of small, steady returns, extending over a long series of years, as has been the case with the greater portion of the enterprises conducted by government or by strong companies abroad, the most substantial work is in the end the most economical; but here, where the effort is too often to get out the largest amount of bullion in the shortest time possible, plans are seldom laid with a view to the remote future. The number of precious-metal mines in this country which have continued to be productive during a period of ten years is very limited, and the life of many of the most famous and successful ones has been far shorter. Indeed, a bonanza which has required two or three years to exhaust is a rarity, and when it is considered that many of the most productive mines have yielded merely a single large ore-body at or near the surface, the short average life is seen to be owing to natural causes as well as to the rapidity of operation. An engineer is hardly to be blamed, then, if he plans for the exigencies of the immediate present; on the one side he is pressed by the stockholder, clamorous for speedy profits, and on the other hand he realizes that the chances of a long period of bonanza are slight. His policy is forced upon him. He aims to secure given results by the most direct means, and when the object has been attained he cares little whether his drifts cave and the structures over his hoisting works and mills fall in, if they have served their purpose.

It is a pretty generally acknowledged saying that foreign engineers and Americans educated abroad have to divest themselves of a large part of their training before they can become successful superintendents of mines in the Far West. The attempt to graft the practices appropriate under other circumstances upon the peculiar disadvantageous conditions of mining in the precious-metal territory of the United States seldom results favorably. The high rates of wages, the difficult transportation, and the great expense (in most districts) of fuel, timber, etc., necessitate altogether different systems. It is possible that there may be such a thing as ultra conservatism; a deference to time-honored customs may be carried too far. To put the case in a concrete form, it may safely be said that had the whole management of our gold and silver mining industry been in the hands of Europeans, following the methods prescribed by their training and experience, less money might have been wasted in fruitless and impracticable enterprises, but on the other hand the gains would have been less in about the same proportion. For a typical example: Imagine a corps of German engineers in control at the time the Comstock lode was discovered. What would have been the result? Looking backward now it is easy to see how many millions of dollars might have been saved which were squandered in ill-advised, hopeless, or disconnected undertakings. But what would the foreign engineers have done? They would have worked out the surface ore-bodies of the Ophir, the Gould & Curry, etc., to the best advantage, doing in, say, ten years work which occupied by more wasteful but more expeditious methods only three or four. They would then have had to contend with the water problem. They would have driven the comparatively short adits freeing the mines of water to a depth of a few hundred feet, and finally, perhaps, would have projected the Sutro tunnel, but from that day to this operations would have been confined to ground above the Sutro tunnel. Per contra, a large amount of low-grade ore (neglected by the actual miners) would have

been taken out and worked at a small profit, and a field for labor would have been opened which would have lasted for decades. It is hardly likely that they would have projected the deep shafts, some of which, like the Forman, destined to strike the lode at about 4,000 feet, might have been considered foolhardy undertakings; and it is quite likely that the unprofitable deep explorations of late years would never have been countenanced. In the long run it is possible that the supposed system of the German engineers would have proved more economical, could it have been carried out; but it must be remembered that the mainstay of development, the money necessary to prosecute dead work, depended upon the speculative interest, which looked to brilliant and speedy discoveries of great bonanzas, and that this interest could hardly have supported the delay which would have resulted from a system more economical but less suited to the time and the locality.

One advantage which has prominently asserted itself in American mining is the intelligence and versatility of our skilled mine operatives. It may be true that for underground prospecting Mexicans may be superior, and it is certainly true that in plain work, such as drilling, blasting, and picking, Cornish and Irish miners are employed to a large extent; but the engine-drivers, the rope-men, the pump-men, the timber-men, the machinists, the millmen, are mainly native Americans. Our mining system is also in a broad sense an eclectic one, with the advantage of drawing hither the better classes of operatives from all sources.

In older countries the distances between the mining regions and the points of supply are generally small; freights are therefore cheap, communication by rail being the rule. The population is comparatively dense, and wages are therefore low, often reaching a point which would not furnish a bare subsistence for the miner of Nevada or Idaho. With good transportation facilities it is possible to operate large reduction works capable of profitably treating in mixed charges ores of different characters which it would be useless to attempt to reduce alone. Supplies, such as fuel, explosives, and steel, are relatively cheap. There are no excessive altitudes, and in the mining regions of Europe at least there is no extreme climate. And above all, perhaps, there is always a near market for products and by-products, some of the latter forming important items of profit.

In most of the mining regions of the Far West all this reversed. Often great distances have to be overcome by wagon-haulage, involving a freight charge seldom as low as one cent per pound in the more favored localities, up to six or eight in the more distant camps. The resident population is usually scanty, and dependent upon the mines rather than self-sustaining or tributary to them, and the cost of living is always higher than in agricultural regions, higher than in the eastern states, and much higher than in any civilized foreign country. This leads to higher wages; and in most districts of the Pacific slope, except in California, the rate is $4 per shift, whether of eight, ten, or twelve hours, for skilled miners, and $3 per day for surface laborers. While these men live better than their fellows of the eastern states, they are seldom able to accumulate savings, even with the increased wages, owing to the greater cost of living.

As a rule, it has been necessary to reduce the ores of each district by themselves. In the case of milling ores this would make little difference, for such ores need to be treated separately, but with smelting ores success often depends on the admixture of different kinds. Latterly, however, a few large smelting and general reduction establishments have been built at railroad centers, and these works handle ores from widely-scattered districts and of a large range in character.

Mining supplies are generally very dear, though the particular want in each district may differ. In many districts timber has to be hauled from a great distance, the supply of mine timbers used at some of the more distant camps of Nevada being derived from the Sierra, brought by rail and wagon over such long distances as to render the cost almost prohibitory. Over a large stretch of territory fuel is very scarce and the quality of that obtainable poor. Only in a small proportion of the districts is coal to be had, though as the railroads are pushed the use of coal is extending, as in parts of Colorado, Utah, and New Mexico. But few of the coals of the Far West can be made into coke—a necessity in certain branches of smelting—and coke is therefore carried from points as remote as Connellsville, Pennsylvania, and in some cases even from Wales. Charcoal of excellent quality is obtainable in many localities, but around some of the smelters the scanty growth of timber and brush has been long since stripped off, and the supply of charcoal has to be brought from a distance. For generating steam, wood is the common fuel. The increased cost of machinery, as compared with its price in the manufacturing centers, is the result of the heavy freights; and the same is true of such supplies as steel, candles, explosives, chemicals, etc.

The high altitudes, the rugged character of the country, and the severe winters are great drawbacks. Not a few camps are practically shut off from communication for several months each year. In some of the less important districts thus situated work is then suspended; in others it is carried on at great disadvantage. Besides the freight blockade caused by the heavy snows, trouble and danger often result from snow-slides. If the winters are unfavorable in the northern and higher districts, the summers are hardly less so in portions of Arizona and New Mexico.

It will thus be seen that there are peculiar natural disadvantages as compared with the conditions which prevail in the European mining districts, and indeed in most portions of the world in which mining for gold and silver is prosecuted. Almost all items of expense are more costly than in foreign countries, labor invariably so, and supplies usually, though perhaps in less degree. California, more settled, and largely an agricultural state, is to some extent an exception. The cost of mining and of reducing ores being so high, many of the smaller economies

of older countries are out of place. In one instance, in reply to the criticism of a foreign engineer who thought the percentage of metal extracted from the contents of the ores to be excessively low, it was only necessary to explain that the ore was the cheapest thing in the district. The superintendents are fully informed as to the means of close working, but however anxious they are to show fine technical results, they are ever held to the economic limit. There is always a point beyond which saving costs more than it is worth, and at this they are forced to stop.

It may be said that as time passes and the country is more and more developed our systems of financial management of mines are slowly approximating to those of Europe. In a few branches of mine engineering we also borrow, and in a wider range of metallurgical operations we are adopting European methods. On the other hand, many American practices have been copied elsewhere. The California stamp battery, the Washoe pan process, the water-jacket furnace, the hydraulic nozzle, etc., have been introduced in many new regions where appropriate. There is also a demand for engineers of American experience in opening new districts and in such countries as Mexico and the states of Central and South America, and these men carry with them their own systems. A point worthy of consideration is that there is unquestionably a greater variety of ores, not only of gold and silver, but of other metals as well, in the United States than in any other single country; so that the mines are schools of practical technology in which all specialties are developed, and in each something may be gained by comparison with the related industries.

SCOPE OF THE INVESTIGATION.—In undertaking the investigation of the statistics and technology of the precious-metal industry of the United States it was the object of those in charge of the work to make, not only a more accurate statistical estimate of the actual product of the precious metals than had hitherto been made, but also to obtain such technical data as to the various processes by which these metals are reduced from their ores as would serve to show the actual condition of the industry, the advances it has made as compared with former periods, and its relative perfection and imperfection as compared with similar industries in other countries.

These technical data it was expected would furnish to mining engineers, and to those interested in mining throughout the country, the materials to make such generalizations in any particular branch in which they might be interested as would tend to practical ameliorations, and would enable them, by comparing the practice in their own regions with that of other parts of the country, to determine where and how economy or improvements might be introduced. They would serve, moreover, as an indispensable basis of comparison with results to be obtained at future periods, when similar investigations might be undertaken.

METHODS EMPLOYED.—In considering, at the outset, the best practical method by which such an investigation could be carried on, it was found that no information could be drawn from the experience of former American studies, inasmuch as no such far-reaching and detailed examination of this industry had ever been attempted in this or any other country, at least as far as could be learned. It was well known, however, to all who took part in making the original plans, that precious-metal mining and its allied labors presented peculiar obstacles to carrying out such a work, far greater than obtain in other industrial branches, from the fact that it is carried on in regions remote and difficult of access, that its business methods are relatively unsystematic, and that it is often of such a nature as to render those engaged in it extremely unwilling to have their transactions known to the world. While, therefore, the census staff were aware that in the nature of things absolute completeness of results was impossible, they felt that with the unprecedented advantages which the present census offered for carrying on an investigation they would not be justified in attempting less than they have done, since only actual experience could tell in what particular respect they might be successful and in what they must necessarily fall short.

It was evident beforehand that the ordinary system of obtaining statistical information by sending circulars, or lists of questions to be answered, to all persons in charge of mining operations throughout the country, would be impracticable: First, because there were no certain means of obtaining their addresses; and second, because it was probable that, either through unwillingness or ignorance, a large proportion of the questions would be either imperfectly answered or entirely neglected, and it would be impossible to have any check on the completeness or accuracy of the answers obtained.

The plan finally adopted, therefore, was that of sending to every mine or reduction works in the country men of technical training and familiarity with the subject, to gather the necessary information personally, and assure themselves by local observation of the accuracy of the information obtained.

To aid these examiners a series of questions, arranged in schedules for each branch of mining and reduction process, was prepared after long and careful consideration, which should cover as far as possible all points of inquiry and also furnish checks on the accuracy of data given; intended thus to supplement any shortcoming in technical knowledge on the part of the expert and to systematize the data which he might send so as to facilitate the work of the compiler.

To carry out such a plan to theoretically perfect completion, four requisites were necessary: An amount of time and of money disproportionate to the value of the results to be hoped for, a sufficient number of men both theoretically and practically familiar with all branches of the industry to act as experts, and a uniform willingness and ability on the part of those applied to to furnish the desired information.

In point of fact, however, after the work had been some time under way, it was found that both the time and the money which could be allotted to this branch were inadequate to carry it through with the perfection aimed at; that it was impossible to find the number of men required who were in every respect fitted for it by education and experience; and that among owners and superintendents of mines and reduction works, while with a very few unimportant exceptions the greatest willingness was shown to grant us all the information they possessed, it was often found that they were themselves unable to answer the questions we asked, either through want of system in keeping records, or because they had never thought of the importance or bearing of certain facts. In spite of these drawbacks and of the further fact that by the exhaustion of the general census appropriation the work of compilation was greatly curtailed and delayed, the results obtained have proved beyond expectation valuable and instructive. The imperfections of the work none know better than its authors.

CRITICISM OF RESULTS.—It may be of value to the reader, and certainly will be to whoever may undertake a work similar to this in the future, to consider briefly the comparative value of the results obtained, the reasons of their imperfections, and the merits and faults of the methods employed.

For the geological sketches of the mining regions (Chaps. I and II) it was hoped that the collection of specimens prescribed, and the answers to the schedule questions, supplemented by the observations of individual experts, would afford sufficient data for a brief *aperçu* of the geology of each mining district. In practice it was found that, as most of the experts had at the best but a theoretical knowledge of geology, the information gathered was in most cases quite inadequate. Such of it as was deemed sufficiently important has been concisely presented in the form of tables, while the rest of the chapters are made up largely from the personal knowledge of the authors and from such facts as could be gathered from published and unpublished observations of others. They are necessarily much more complete in some regions than in others, but, in spite of acknowledged imperfections, are believed to form a most comprehensive and valuable contribution to mining geology.

In the preparation of the two succeeding chapters the greatest difficulty was found in the inequality of the schedule returns, dependent upon circumstances which will be explained below. A large proportion of the material collected was of such character that it was almost impossible to tabulate or condense it. Much of this was not found possible or advisable to publish; that which has been published has been subjected to careful sifting, and is of undoubted value to those engaged in mining, though it may not in all cases appear so to the uninitiated. The data on the Placer Mines were necessarily incomplete, since these are only worked during portions of the year, and the visits of the experts could not be so timed as to find the owners or the superintendents, from whom alone much of the desired information could be obtained. This incompleteness has been supplemented in respect to hydraulic mining from personal knowledge and observation. The process of reduction of ores by amalgamation is one which lends itself readily to statistical analysis, hence the data obtained by experts was here more complete than in most branches of the investigation. Smelting, on the other hand, by the complexity of its processes, and the necessary variation in its details, offers an almost insurmountable obstacle to presentation in the form of statistical tables. No attempt has therefore been made to present the information obtained in these schedules in this form, but it has been of great use as a check in the preparation of the succeeding chapter on Production. Lead smelting is the most important method which is used in the reduction of the Precious Metals, and its conditions present so much similarity in different localities that the description given of the process as carried on at Leadville may, with unimportant changes, apply to any other region where it is employed. For the estimation of the Precious Metal product of the country the synthetic method, as that adopted in this investigation might be termed, in distinction from those hitherto in use, was here employed for the first time, and was in so far an experiment. On the whole it has proved a most successful one, and the results obtained form, as a whole, it is thought the most accurate estimate ever made. Owing, however, to the inequalities of results to be mentioned below, the local distribution of product has in some instances been incomplete, and has given rise to adverse criticism from local interests which conceived they had thereby been injured. Had the text of the chapter been read with sufficient care for a thorough comprehension of the methods of presentation, this criticism would have been seen to be unfounded. The chapter on the Minting of Gold and Silver is the result of a careful personal investigation of the Carson and San Francisco mints, giving thus the practice prevailing in the United States, and forms a fitting close to the Precious Metal volume. In Appendix I a typical detailed description of the conditions prevailing in one of the Precious Metal political divisions—Utah—as space would not have allowed of such detail in all. In Appendix II the schedules and instructions to experts are given, as they were used during the investigation. The Mining Directory in Appendix III is a practically complete list of the Precious Metal mines of the United States in 1880, those which by the nature of the investigation were omitted being as a rule small and unimportant.

A detailed acknowledgment of assistance will be found on a subsequent page.

REASONS FOR INCOMPLETENESS.—The reasons for incompleteness in the results may be thus enumerated:

1st. From want of previous experience, the agents in charge could not distribute equally the ground to be covered among the experts employed, since the number of mines to be investigated bore no necessary relation to geographical area. As a consequence, toward the end of the time devoted to the investigation some regions received less attention than their relative importance merited.

2d. The relative ability of the experts employed was necessarily unknown to the agents in charge until the investigation had proceeded so far that it was too late to make any radical change.

3d. It was a practical impossibility to secure uniformity of ability and methods among so large a corps of experts as was necessary for the work. The result was that one would give more attention to one class of facts, another to another class, and, when totals were made up from the schedule returns, it was found that these facts were more complete in one region than in another.

As regards the best method for conducting such an investigation, the experience gained in this study would seem to teach that, while that employed here would produce the most perfect results under very favorable conditions, these conditions might demand an impracticably large expenditure of time and money. They would require a larger corps of experts, who should be specialists and receive adequate salaries, and be employed for a long enough time to become thoroughly familiar with their work before the investigation was undertaken. This could be best accomplished by making the investigation a permanent one. The results to be obtained by simple untrained enumerators, or from circulars sent without means of checking the results obtained, by technical men, will necessarily prove so unreliable in mining industry as to be of little value. Should the intermittent or decennial method still prevail, a compromise between the two could be advantageously made by having untrained men go over the country rapidly and collect a few main figures for the statistical tables; and a smaller corps of thoroughly trained specialists make investigation of a few typical mines or reduction works in the various branches of the industry.

COMPARATIVE SUMMARY OF RESULTS.—One of the most instructive results of an investigation like the present should be the opportunity it would offer for a comparative study of the industry as a whole and in its individual branches, as compared with the conditions which prevail in other countries, especially the older mining regions of Europe, and as compared with those which prevailed in this country ten years before, and of the changes and improvements which have been accomplished during the preceding decade. As a natural sequence of such a study suggestions would arise as to where improvements could be introduced or greater economy practiced in the future, and the direction in which increase or decrease of production over the present might be looked for.

Unfortunately statistical data for such a comparison are wanting. The census for 1870 gave practically no data at all with regard to our mining industry, and the publications of the Commissioner of Mineral Statistics ceased after 1875.

Hence, as already stated, the best results of this work can only be looked for in later years when similar data gathered on a plan improved by our experience shall furnish a new set of comparative figures. Meanwhile it may be well to offer some suggestions on these points which, while not based on statistical figures, have a sufficient ground-work of actual observation to be of value as an indication of the tendency of the industry.

ADVANCES DURING THE DECADE.—If we assume that the value of an industry to the country can be gauged by the number of people whom it supports, mining during the decade has contributed more than its share toward the general prosperity; for while the increase of the population as a whole has been only 30 per cent., that of the miners has been 54 per cent., or 234,228 in 1880, against 152,107 in 1870.

The total value of the product seems a less certain gauge of its contribution to the actual prosperity of the country, though the value of the precious metals in furnishing the material for a currency cannot be too highly estimated. During the decade the value of the total product reached the highest point yet attained, being 96 millions in 1878, and, in spite of considerable falling off since that year, the general result has been a permanent increase of production. As regards the relative production of the two metals, gold and silver, there has been a notable increase in the value of the latter over the former, namely, from 50 millions gold and 16 millions silver in 1870 to 33 millions gold and 41 millions silver in 1880. The silver production of the country only dates back 20 years, the product of 1860 having been but $150,000. Since that time its yearly amount has increased pretty steadily and with comparatively small fluctuations, while the gold product, which has been subject to greater variations from year to year, has apparently assumed a fixed average between 30 and 40 millions, beyond which it is not likely to vary. While, therefore, our silver product may be expected to increase considerably during the coming decade, gold will probably remain at the same general average.

The cause of the change in the relative positions of gold and silver must naturally be looked for in the ores themselves. While gold-quartz and hydraulic mining have about retained their relative importance, the development of silver-bearing ores, especially those carrying lead and copper, has been most extraordinary. Perhaps the main determining cause of this unusual activity may be that prospectors as a class have now learned the value of these ores, whose outcrops had hitherto been regarded as worthless indications.

Of ores in general it may be said that the richer and purer ones, which alone were sought for in the early days of mining, have been gradually giving way to those of more complicated nature and generally of lower value in the precious metals. Consequently in the reduction processes we find smelting acquiring a relatively more important place than it formerly held, and in milling an increasing use of the dry-crushing process connected with subsequent roasting of the ore and a marked growth of the lixiviation processes.

The two most important factors in the development of the precious-metal industry during the decade have been the extension of railway systems and the introduction of coal as a fuel throughout a portion of the mining regions of the West. In 1869 the first transcontinental railway was opened, and now not only are there practically

four great railway systems crossing the mountains from east to west, but a great number of short lines, generally narrow gauge, penetrate them in every direction, reaching mining towns which not many years since were only accessible by pack trains or saddle animals.

Although the existence of coal in the Cretaceous and Tertiary beds of the West was known before 1870, its development, like that of the railroad system, has practically been the work of this decade. The production of the region west of the one hundredth meridian, as well as can be ascertained from confessedly incomplete data, has increased from about a quarter of a million to nearly two million tons, and it is probable that in the coming decade the rate of increase will be far greater. California, Washington, Colorado, Wyoming, and Utah are now the principal producers, and New Mexico, Montana, and Dakota are yet to be added to the list.

To the development of these two great elements which form the basis of the industrial prosperity of every country may be ascribed the reduction in the cost of labor, supplies, and power, which, in their turn, have produced the most important and healthful changes in the mining industry of the West.

In view of these changed conditions the decrease in the supply of high-grade ores, and the consequent development of low-grade and complex ores, requiring more elaborate processes for their reduction, and yielding a smaller margin of profit to the producer, may be regarded as a benefit, both to the mine owner and to the laborer whom he employs, in spite of the decrease in the actual money return either may receive for his investment of capital or labor. Stability is the most essential condition for the permanent prosperity of any business, and unless this is reasonably well assured the reluctance of capital to embark in it is too well known to require remark. On the other hand it may be more difficult to persuade the laborer that permanent employment at a low rate of wages is more beneficial to him in the long run than the precarious and expensive conditions attendant upon the high rates which prevailed during the fitful extravagance of earlier mining excitements.

The fictitious prosperity of mining consequent upon some new discovery of exceptionally rich and extensive ore deposits is comparable with that occasioned by the inflation of the currency and fever of speculation which prevailed at the close of our civil war, and the reaction which is sure to follow is even more injurious in its effects, since in it more than in any other business is the element of chance a necessarily important factor.

In the direction of stability its advance during the decade has been the most important that has occurred during its history, and especially during the latter five years has there been a notable decrease in the fever of mining speculation. It may be said that, in spite of the falling off in the production of the Comstock and other important mines, the actual earnings as a whole are probably greater than ever before.

Among the general improvements may be noticed the more frequent employment of scientific methods both in mining and in reduction, a desire for more accurate geological information as a basis of development of mines, and a gradual dying out of the former unreasoning prejudice in favor of the so-called practical miner over the educated engineer.

The principle of combination is also beginning to enter more largely into both branches. In mining it is seen in the combination shafts and pumping machinery, of which the most notable intstances may be seen on the Comstock lode, where all work in the lower levels is carried on from a few large shafts owned by two, three, or even five mining companies, and most winzes, together with many exploring drifts, have a joint ownership. In reduction works it is seen in milling in jointly-owned amalgamating mills and large custom works, in which, by reason of their greater size, a marked economy in running expense is effected. In connection with smelting it is seen in the ever-increasing number of sampling works which afford to the small miner on the one hand a certain and immediate market for his ore, and on the other assure the smelter a more regular supply of ore of known and comparatively regular composition.

More attention has been given than hitherto to the concentration of low-grade ore prior to shipping, but in this direction there is still much room for improvement, and until properly-constructed concentration works are established, enormous bodies of sulphuret and other low-grade ores now actually developed in many mining camps must remain as valueless as they are at present.

If we examine into the technical details of exploitation of mines, milling, or of smelting, we find no very important advances over the best class of work that prevailed ten years ago, the conditions of which are admirably set forth in the volume on Mining Industry of the Fortieth Parallel publications, by Mr. J. D. Hague. The changes which seem most worthy of note are briefly as follows:

In mining.—a. The general introduction of high explosives, such as Giant, Hercules, Vulcan, and other nitro-glycerine powders, in underground work, where they can be used in wet ground and require smaller drill-holes. These were just being introduced at the commencement of the decade. A series of low-power explosives, such as Judson, have also in part supplanted black powder in bank blasting.

b. The use of and improvement in power drills. Many large mines now use percussion drills, driven by compressed air, for running drifts and tunnels, though their use is not so economical as a rule for vertical openings, such as shafts and winzes. Wherever mining is done on so large a scale that power must be used to a considerable extent, the use of drills is bound to increase, and gang-drills such as are employed in driving the great tunnels of the Alps will also in time come into use.

c. The capacity of machines for compressing air, used not only for drills but for underground machinery in general, and as a consequent aid to ventilation and for cooling the air, has sensibly increased, air being readily carried several thousand feet and delivered at a pressure of 60 to 75 pounds. Larger and better blowers, used for ventilation and for blast purposes, are also made.

d. The diamond drill has been more largely used, though experience has shown its value as a prospecting tool to be perhaps less than as a safeguard in a mine against sudden inrushes of large bodies of water.

e. The more general use of compound engines, and consequent economy of power in mining machinery generally.

f. For hoisting, steel cables have almost entirely superseded those of iron wire. Hemp is still used in small shafts and for shallow depths. The use of the flat as distinguished from the round cable does not, however, seem to have become as general as it should. The number of accidents to cages and consequent loss of life to miners is still large, and an improvement in safety devices is much to be desired.

g. The use of the telegraph and telephone in signaling at mines has been considerably experimented upon, but their employment underground has not proved altogether satisfactory. On the surface the telephone for connecting shafts, mills, and offices is productive of economy of time and labor.

In *amalgamating* there have been no essential changes of practice during the decade. The reduction in the cost of steel has brought about its partial introduction for shoes, dies, and tappets, but the results have not been such as to cause its general adoption; it is mainly used in dry-crushing mills. Large mills of over 100 stamps have been built and proved a success.

Owing to the increase of complex ores and consequent necessity of preliminary preparation of ores before amalgamating, roasting and chloridizing furnaces with mechanical appliances have come into more frequent use.

There has also been an increase in the practical application of leaching systems for the treatment of auriferous pyrites and of base silver ores.

In *smelting*, the use of water-jackets in shaft furnaces and of the siphon-tap in lead smelting has become very general during the decade. Besides this, some minor improvements in the smelting plant, such as the safety-tuyére, have been introduced.

PREFACE.

At the beginning of 1880 the Hon. Francis A. Walker, Superintendent of Census, committed the census investigation of the precious-metal mining industries to the charge of the Hon. Clarence King, then director of the geological survey. The director called upon us to draw up plans for the examination of the technology and statistics of these industries, reserving to himself the organization of an inquiry into mining laws and mining civilization. We accordingly drew up a series of schedules to furnish a basis for the inquiry, which are reprinted in an appendix to this volume. These were submitted to the director, and by him to the Superintendent, and were duly approved. Thereafter the conduct of the inquiry was left entirely in our hands.

It was not expected that answers to all the questions proposed could be obtained at any one mine or reduction works, nor was it the intention to limit the inquiries to these questions. The purpose was rather to suggest subjects of inquiry and assist the visiting experts to frame the best possible report on the mines and reduction works in the short time necessarily allowed to each mine. The questions were also so framed that the more important data are involved in the answers to several of them, a measure intended to guard against errors of recording and mistakes in statement, as well as intentional misrepresentation. This system was of great use to the experts in detecting erroneous statements, as it has afforded the office an excellent check on the accuracy and care of the experts, and has led to the rejection of some inferior work.

As will be seen from the instructions, the examination was limited to mines which showed at least 300 feet of shafts and galleries, or which had produced 100 tons or more of ore. This was plainly an inevitable measure, for had the attempt been made to examine every mine, however small, the task would have been absolutely endless. Many times the number of experts who could be paid out of the allotted fund would have been needful to visit even the prospects opened in the census year alone. At the same time, of course, all thought of obtaining exhaustive statistics was abandoned. In other words, the investigation was planned, and inevitably so, with a view to obtaining as large a number of representative facts as possible from which to draw general deductions, and it was distinctly recognized that even a very close approximation to any actual totals could be obtained from direct returns only at an inordinate expense and at the sacrifice of the comprehensiveness of the investigation. It was believed, however, that sufficient information could be secured to supplement and check certain totals derivable from other sources, and in many cases enough to form the basis for estimates of totals sufficiently close for any purpose to which statistics are actually applied. On a great number of subjects absolutely accurate totals, if they could be obtained, would be mere curiosities, and of no more use than approximations, with a probable error of 5 per cent. In the examination of technological questions totals are usually of very little consequence, and what is needed is statements as to construction or practice, founded on a sufficient number of instances to secure their representative character. It was plain that the results which could be obtained would depend largely upon the competency of the experts engaged in the direct collection of the required information. Only men of considerable experience, as well as thorough training and much energy and ability, could really answer the requirements, as any professional mining man who glances at the schedules will readily appreciate. Men of this stamp are never readily to be procured, and the small salaries which could be paid caused an additional difficulty. The gentlemen secured were all honest, faithful, well educated, and able, and a part of them had ample experience. Their names and the districts to which they were assigned, together with the organization by divisions, were as follows:

PERSONNEL OF THE PACIFIC DIVISION.

The headquarters of this division was placed in San Francisco, and the direction of the work confided to Mr. George F. Becker, United States geological survey, geologist in charge of the Pacific division. This division includes the states of California, Oregon, and Nevada, and the territories of Idaho, Utah, Arizona, and Washington.

Mr. J. M. Cunningham, for the eastern portions of Washington and Oregon and the northeastern part of California.

Mr. J. S. Curtis, Nevada south of the line of the Central Pacific railway.

Mr. J. H. Hammond, central and eastern counties of California.

Mr. D. B. Huntley, Utah, southwestern Nevada, and portions of California.

Mr. H. W. Leavens, the tract lying west of the Cascade and Coast ranges in Washington, Oregon, and northern California.

Mr. Walter Nordhoff, southeastern and middle Arizona.

Mr. H. W. Sander, western Arizona.

Mr. Luther Wagoner, southern California.

Mr. Albert Williams, jr., Idaho, Nevada north of the Central Pacific railway, and the Comstock lode.

PERSONNEL OF THE DIVISION OF THE ROCKY MOUNTAINS.

The division of the Rocky mountains adjoins the division of the Pacific on the east, and extends eastward as far as the one hundredth meridian, including the state of Colorado and the territories of Dakota, Montana, New Mexico, and Wyoming. At the head of this division was placed Mr. S. F. Emmons, United States geological survey, geologist in charge, with headquarters at Denver.

Mr. W. B. Fisher, portions of Lake, Chaffee, Clear Creek, and Gilpin counties, in Colorado, and Beaverhead county, in Montana.

Mr. William Foster, Montana and Wyoming.

Mr. J. E. Hardman, the smelting works in Lake county, Park and Summit counties, and portions of Clear Creek and Gilpin counties, in Colorado.

Mr. Charles Potter, New Mexico.

Mr. E. H. Schaeffle, Dakota and portions of Colorado.

Mr. W. G. Sharp, San Juan, Hinsdale, Gunnison, La Plata, Huerfano, Ouray, and Rio Grande counties, in Colorado, and portions of New Mexico.

In addition to the census experts the following-named gentlemen acted as temporary assistants: Messrs. Herman Garlichs, J. C. Hine, H. B. Price, H. L. Simmons, and W. H. Whittlesey, in Colorado, and W. F. Wheeler, in Montana.

PERSONNEL OF THE EASTERN DIVISION.

The eastern division comprises the whole territory lying east of the one hundredth meridian. Professor Raphael Pumpelly, United States geological survey, was placed in charge, with headquarters at Newport, Rhode Island.

Mr. George H. Eldridge, southern states and reduction works east of the one hundredth meridian.

Professor N. S. Shaler, with the assistance of Messrs. Jos. M. Wilson and J. E. Wolff, New England states.

We were able personally to take but a small share in the collection of the data, for, beside duties unconnected with this investigation, much time and labor were involved in advice to the experts as to routes, in the decision of doubts referred to us, the approval of expenditures, and the multifarious matters of administration implied in keeping twenty men (all of them unfamiliar with the conditions and restrictions of government work) moving without delay and performing their duties to the advantage of the service.

Excepting one or two who were engaged at an advanced stage of the examination, all the experts were in the field before the expiration of the first month of the census year; but it was found that the time involved in the collection had been underrated, chiefly on account of the difficulties of traveling after winter had set in. Additional time unfortunately meant additional expense, and we were reluctantly obliged to stop field-work before we were quite ready to do so.

The compilation followed, and for lack of census funds we were obliged to call upon the geological survey for a large part of the expenses incurred.(a) Our thanks are due to Hon. J. W. Powell, director, for the substantial aid which he has furnished us. Mr. Albert Williams, jr., who had distinguished himself by the judgment and energy which he had displayed as special expert in his examination of Idaho and northern Nevada, was appointed to take direct charge of the compilation under our supervision and co-operation. This task he has accomplished to our entire satisfaction. There is no doubt that statistics lose some of their value by not appearing promptly; but though we have realized this fact throughout the investigation, it has been entirely impracticable to proceed more rapidly. Only a very subordinate portion of the work was of such a character as to permit of tabulation by clerks devoid of a professional knowledge of the mining industries. Each of us was personally engaged in geological investigations of important subjects, as the publications of the survey will show, and could give but a portion of our time to technology and statistics, while a greater expenditure for expert assistance was out of the question.

The work has been pushed with all possible energy, and when for a period of several months no public funds could be procured Mr. Clarence King advanced the necessary money without interest, so that not a single working day has been allowed to pass unutilized.

In preparing the data for publication it became a question as to how far estimates should be introduced. After careful consideration, it was decided to introduce no estimates except such as might be specifically mentioned.

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a Our own services to the Census Bureau have, of course, been entirely gratuitous throughout.

This throws certain parts of the work open to criticism as to completeness. These it would in most cases have been easy to cover by estimation, but in doing so the integrity of the figures given would have been destroyed. Readers will probably find few imperfections not familiar to us and for which sufficient grounds could not be given, which in most cases were a lack of funds to carry the field-work to an end as planned. In one set of tables there seems to be internal evidence of manipulation, but this is only apparent. When the tables of production were first transmitted, the quantities of bullion were entered both in dollars and in ounces. The practice in respect to the unit used for bullion varies in different parts of the country, some mines reporting dollars and others ounces, so that in some cases we had to convert ounces to dollars and in others dollars to ounces. Our figures were reviewed at the central office to test their correctness, but in the revision it was assumed that the ounces were the original data in all instances. In recalculating the dollars from the ounces the conversion in some cases resulted in inevitable, though unimportant, discrepancies, and the numbers were altered accordingly. The change was not known to us until the matter was in type, and it then seemed scarcely worth the while to make the insignificant corrections in value at a great expenditure in labor. The reader will readily understand that where a district is reported as producing $9,999 the actual return was $10,000.

In the table upon which technological deductions are made the number of mines or other establishments reporting is stated. It is, of course, to be understood that this is the number of mines or works from which we have reports on this particular subject, not the total embraced in the investigation. The extent to which generalizations are permissible from the data of any table will be evident from this figure to those familiar with the industry.

The discussion of hydraulic mines and ditches is almost wholly the work of Mr. Williams; the chapter on milling is founded largely on a report made by Mr. J. S. Curtis; the chapter on smelting in Leadville is founded on a report by Mr. A. Guyard; the discussion of the mints of Carson and San Francisco is due to Mr. Williams; the report on the mining industry of Utah is by Mr. D. B. Huntley. All of these are founded on the schedules, and all of them have undergone criticism and revision at our hands, while some have received extensive additions or modifications. Each of us has sketched the geology of his own division.

Orders having been issued by the Superintendent to condense the census memoirs to the smallest possible compass, a large amount of valuable material is omitted, some of which it is to be hoped will be made available in future publications of the survey. Had there been room many details would have been published by mines or works which are now given only for districts; but this could have been done only at the expense of an unallowable increase in the size of the memoir. We have reports on other regions corresponding to that of Mr. Huntley, though this is not the case for all the states and territories, and the records contain a very large number of descriptions of apparatus and practice which would be well worth publication. Mr. Huntley's paper was given a place in the appendix, because Utah is in many respects a representative mining region, and because the report seemed to us of unusual merit. The schedules are allowed to appear as showing the plan of the investigation, and as affording some suggestions for the study of the industry which may be of use to others.

The trustees and officers of the American Museum of Natural History, New York city, very kindly placed at our disposal fine working rooms in the museum building, which were occupied during the period of compilation; and for this courtesy the sincere thanks of the authors are tendered.

S. F. EMMONS.
G. F. BECKER.

In the course of the repeated delays which have occurred in the publication of this volume since it left our hands, delays for which we are in no way responsible, and of the transfers of the manuscript material from one depository to another, a series of topographical maps, intended to accompany the geological sketches of the several states and territories, and colored to show the distribution of gold, silver, and quicksilver, has been lost. The further delay which would be necessary to reconstruct these maps is found, greatly to our regret, to be impracticable.

STATISTICS AND TECHNOLOGY OF THE PRECIOUS METALS.

CHAPTER I.—GEOLOGICAL SKETCH OF THE PACIFIC DIVISION.

BY GEORGE F. BECKER.

It is the purpose of this chapter to present such an outline of the geology of each of the states and territories west of the Rocky mountains as will serve to assist those unfamiliar with the country in forming an idea of the character and distribution of its mineral resources, and to convey such rudimentary information concerning the relations which the ore deposits bear to the larger features of the geological structure as is necessary to an intelligent perusal of the statistical chapters. The information available for this purpose is far from ample. The government geological explorations of the last twenty years have done a large amount of extremely valuable work, some of which has made a permanent mark on the history of the science; but the territory is so vast that many decades must elapse before even the preliminary explorations are completed. The collections and the data gathered by the census experts are also very valuable. Few mines, however, can be properly understood without a somewhat extended examination of the surrounding country, for which the experts had no time, and the information is therefore rather fragmentary.

The order adopted in sketching the states and territories is not that which would have been chosen had the information been more complete. Washington territory and Oregon are placed after California, because little is known of them directly, while certain inferences may be legitimately drawn from the analogous territory embraced in the last-named state, and Idaho is described after Nevada and Utah for similar reasons.

The regularity of the distribution of ores in the Pacific division and its relations to the singularly uniform topography long ago drew the attention of writers to the resources of this region. Mr. W. P. Blake (*a*) first published a note on the subject in 1866, and his statement was accepted and enlarged upon by Mr. King (*b*) in 1870. The more detailed technical and scientific investigations of later years have greatly increased our knowledge of the distribution and extent of the ores, and it will now scarcely be maintained that there are more than four well-defined and continuous ore belts west of the Rocky mountains. Beginning at the east, the first is that at the western foot of the Wahsatch and the southwestern continuation of that range. With the exception of the Leeds (Silver Reef) district, all the important ore deposits of Utah lie in the foot-hills of this range, bearing a very definite relation to the main line of crests. The gold and copper belt of California stands for a long distance in a similar relation to the Sierra Nevada. The quicksilver belt in the California coast ranges is not quite so regular in its occurrence, yet its direction is very nearly parallel to the coast, and it is very persistent, though nowhere broad, for some 300 or 400 miles. The Arizona belt is less known than any of the others, but no one can glance at a map of the territory showing the mining districts without perceiving that these lie in a northwestern and southeastern line diagonally across the country. The mining districts in Nevada are extremely numerous, so much so indeed that some grounds could be given for assuming a belt to run in almost any desired direction, but they are scarcely close or regular enough in any one line to compel the observer to regard them as connected.

These four distinct belts appear to have an intimate connection with the four great orographical changes which the region west of the Rocky mountains has undergone during its geological history. The last of these was post-Miocene, and resulted in the uplift of the Pacific Coast ranges and the great interior valley of California, with a large part of Oregon and Washington territory. The disturbing force seems to have been most powerful to the north and south of San Francisco, or approximately in the region marked by the quicksilver deposits. A post-Cretaceous upheaval raised the whole western central portion of the continent now occupied by the complex system of the

a Annotated catalogue of the principal mineral species hitherto recognized in California, etc. Report to state board of agriculture, p. 26.

b *Exploration of the 40th Parallel*, iii, p. 5.

Rocky mountains. The Wahsatch forms the western edge of this uplift, and the dislocation took place on an old fault coincident with the present western foot of that range. Here also lie the numerous mines of Utah. The Sierra Nevada and the ranges of the Great Basin were raised by a post-Jurassic uplift. The line of most intense disturbance coincided with the Sierra, and the greatest dislocation occurred along its western foot, in the gold belt, though it also extended to the south of that wonderful series of deposits. The earliest disturbance in the far west was that which raised the Palæozoic strata of eastern Nevada, western Utah, and a portion of Arizona above the surface of the ancient sea. The western limit of this Palæozoic area has been traced in detail across the belt surveyed by the exploration of the fortieth parallel, and in that latitude it trends nearly north and south in longitude 117° 30′. To the south the limit has been fixed at a considerable number of points, though it has not been followed in detail. South of Austin the course of the western edge of the Palæozoic is somewhat west of south, and it enters California a little north of Owen's lake. In this region it is deflected toward the southeast, crosses the Colorado river in Virgin cañon, passes by Prescott, and on through Arizona to the neighborhood of Tombstone. The main Arizona belt of deposits has the same trend as the border of the Palæozoic, and nearly coincides with it in position. In short, though the relation still requires much investigation, the Arizona mineral belt appears to stand in nearly the same relation to the western edge of the post-Carboniferous upheaval as do the belts of Utah and California to the other uplifts. That these relations exist as a matter of fact is beyond question, though it is possible that they may be accidental. In any case, however, the uplifts, as such, are not to be regarded as the cause of the formation of the mineral belts; these must rather be due to the fissuring of the rocks and the dislocations attending the orographical changes. There is evidence that the post-Carboniferous uplift in the state of Nevada and in southeastern California was comparatively gentle, and that it was not attended by any considerable crumpling of the strata. This would account for the fact that the number of ore deposits at its edge in these states is not very large. Nevertheless, the lead deposits of Battle Mountain, the Austin mines, the Candelaria district (which includes the famous Northern Belle mine), Panamint, and Cerro Gordo all occur at or close to the western edge of the Palæozoic. Taken in connection with the geological similarity of their position to that of the Arizona mines, these deposits may perhaps fairly be regarded as the rudiments of a belt. In Arizona the area in which the contact occurs has been too little investigated to allow of any statement as to the violence of the uplift, but, all things considered, it would be remarkable if it should not ultimately prove to have been attended by much disturbance.

This theory of a relation between the ore-belts and the lines of uplift is, of course, not to be understood as equivalent to the assertion that the deposits are to be found only along a single line representing the actual main fissure of the uplift. One is apt to think of the dislocation attending an orographical change as confined to a single vertical or highly inclined surface, but every geologist is aware that this is not an exact view. Simple fissures in the earth's crust are very rare, and parallel sets of fissures, with cross fractures and stringers into the surrounding country, are the rule even in the case of insignificant cracks. In disturbances such as those of the great uplifts a considerable belt of country is almost necessarily crushed and torn, and innumerable rents and cracks standing in most complex relations to one another penetrate the rocks in many directions. The breadth of such a zone must usually be measured in miles.

It may be that some of the ore deposits of the Pacific division are independent of volcanic action, but the association of eruptive rocks with ores is a rule with comparatively few apparent exceptions, and in many cases the agency of solfataric action (*a*) is manifest. This has long been recognized by observers.

That there are relations between the rocks inclosing ore deposits and the character of the ores has been known to miners for centuries, but the study of the nature of this dependence is comparatively new. It is far too complex a subject to be discussed in this chapter, but it may at least be stated that the census collections and data appear to confirm, emphatically, the existence of such relations. Lead ores are almost invariably accompanied by limestone, and veins in granite present only a very small number of associations of minerals, which are possibly reducible to a single one. Deposits in metamorphic rocks, too, though more varied than the others, appear to represent but a few types. It was not practicable, however, for the experts to make such minute examinations of the mines as would have been necessary to furnish material for a conclusive investigation of this subject.

With some hesitation most of the determinations of the ore and gangue minerals, the country rocks, and the kind of deposit, are introduced county by county. There can be no doubt that the list of ore minerals is often imperfect. The determination of the wall rocks is subject to some uncertainty without a thorough examination in the field as well as in the study, and the nature of a deposit is in many cases not to be decided by a single visit. It is probable, however, that the determinations of rocks and minerals are nearly always correct as far as they go, and in the cases in which the character of the ore deposits was not clear as much may generally be inferred from the statement regarding them. The tables, therefore, contain much information of value, and many suggestions to such geologists and miners as are careful to remember that they are not exhaustive statements. Except in a few cases, in which I happened to have visited the localities, the determination of the character of the deposits rests on the authority of the experts. The determinations of rocks and minerals inclosed in parenthesis are also due to the experts,

a As originally employed, the term solfataric action denoted only the effect of gaseous emanations from volcanic vents. In use, however, it has gradually come to include the action of heated waters charged with these gases or holding them in solution, and is so employed in this chapter.

while the remainder I have made from the specimens collected by my assistants. The difficulties met with in making these determinations were considerable, for rocks near ore deposits are usually much altered, and the ore minerals need much closer attention than in ordinary specimens of merely mineralogical interest. A few minute particles of such minerals in a hand specimen often make the difference between waste rock and rich ore and the inspection of the samples needed to be correspondingly searching.

Maps of the states and territories of the Pacific division accompany the sketches. These are necessarily on a small scale, but present the leading features sufficiently well to assist the reader in following the descriptions. On them are entered signs indicating the distribution of gold, silver, and quicksilver. These are not designed to represent every spot where precious metals have been detected, but to indicate at a glance their general distribution.

GEOLOGICAL SKETCH OF CALIFORNIA.

The mineral resources of California are extremely varied, but are also of very unequal importance. Its gold production is an essential factor in determining the relations of the mediums of exchange throughout the world, its total value since 1849 exceeding $1,200,000,000. Its quicksilver production, also, though of far less value, exceeds that of any other country. The total known product of California from 1850 to the close of 1880 was a trifle less than 91,600,000 pounds, of an average value of 71 cents, and has yielded above $65,000,000. It is important as an adjunct to the precious-metal industries no less than as an independent source of profit. The silver product yields above a million per year; and the coal-fields, though not of the best, furnish a large part of the supply necessary for home consumption. Asphalt and petroleum are obtained in small quantities, and some sulphur and borax are extracted, while lead is reduced only as an incident of the silver industries, and copper and iron, though their ores are plentiful, are worked on a small scale only. Tin, chromic iron, black oxide of manganese, and other useful minerals also occur in the state, but as yet contribute little to its commercial prosperity.

The great industrial importance of the gold production of California has drawn the attention of many geologists and engineers to the geology of the state, and the literature on the subject is comparatively extensive. The Pacific railroad survey, Mr. J. A. Phillips' work on gold and silver, the reports of the mining commissioners, the proceedings of the California Academy of Sciences, and the scientific journals of America and Europe, all contain contributions to the subject; but the chief source of authority is the volumes of the state geological survey of California, conducted under the charge of Professor J. D. Whitney, who had the assistance of Messrs. Clarence King, W. H. Brewer, W. M. Gabb, William Ashburner, W. H. Pettee, and others. Unfortunately, the legislature ceased to appropriate funds for the survey in 1874 before a single geological map had been issued. Professor Whitney, however, has continued to work up the material collected, and has issued a number of volumes during the last eight years. The census reports and collections also furnish some information of value from a geological point of view, but the following sketch owes most to the data collected by Professor Whitney and his assistants or recorded in the volumes published under his supervision.

The interior of California forms a long, oval valley. Its greater diameter is parallel to the coast, and extends from the neighborhood of Fort Tejon to Mount Shasta, a distance of 450 miles, while the average width is about 40 miles. This valley is surrounded by mountains, except at a single point, where San Francisco, San Pablo, and Suisun bays afford an outlet for the drainage gathered by the Sacramento river from the north and the San Joaquin from the south.

Though the mountain ranges inclosing this basin unite at its extremities, the Great Valley is not a mere undisturbed area between different ranges of a complex chain; on the contrary, the Sierra Nevada to the east and the Coast ranges to the west represent upheavals of different characters and widely distant eras. The Sierra Nevada is a single range forming the western rampart of the elevated plateau of the Great Basin, and was raised in post-Jurassic times. The Coast ranges consist largely of detritus from the Sierra; they were uplifted for the most part at the end of the Miocene, and constitute a mountainous belt of country to which even the name of chain can scarcely be applied. No term answering to the Coast ranges was used by the Spanish settlers of the country, but they gave special names to a considerable number of small ranges within the Coast belt, and these are still in use. The elevation of the Coast ranges is greatly inferior to that of the Sierra, a number of peaks of the latter exceeding 14,000 feet, while none of the culminating points of the Coast ranges appear to rise more than 6,000 feet above sea level.

Both the Sierra Nevada and the Coast ranges are greatly metamorphosed and contain extensive deposits of useful minerals, and the alteration of the strata and the deposition of ore are probably in each case related phenomena; but the metamorphosis and ore-deposition of the Coast ranges occurred long after the cessation of similar activity in the Sierra, and led to widely different results. The more remarkable deposits of the Coast ranges are cinnabar, chromic iron, coal, asphalt, and mineral oil, while gold and copper are characteristic of the western slope of the Sierra, lead and more or less auriferous silver occurring very extensively on the eastern slope, of which only a portion lies within the limits of the state.

The backbone of the Sierra is granitic, the higher summits and a large part of the western slope of the range being of this rock, except in the northern portion of the state, where it has been covered by basaltic and

andesitic lavas. The granite penetrates some of the accompanying strata in dikes, and Professor Whitney regards it as beyond question of eruptive origin, while some other geologists see in it only highly metamorphosed sedimentary material reduced to a plastic state *in situ*. Except at the northern end of the Great Valley, near Mount Shasta, and near Owen's lake, no Palæozoic strata have been identified. In the Gray mountains, Shasta county, a limited area of Carboniferous limestone occurs, amply identified by fossils. A small amount of limestone with the same external characteristics occurs farther south, and Professor Whitney regards it as not improbably of the same age. From a mining point of view, however, it is insignificant, carrying little gold. The principal strata on the west flank of the Sierra are Jurassic and Triassic, occurring chiefly and characteristically as slates and shales. They are highly metamorphic, contain few fossils, and have been profoundly disturbed, showing that the range was uplifted since their deposition. These are the main gold-bearing rocks, and will be more particularly described further on. Near the foot of the range are areas of Cretaceous and Tertiary beds, chiefly marine, nearly horizontal, and resting unconformably on the upturned auriferous slates. Above the Mesozoic slates lie fresh-water auriferous gravels, mainly of Tertiary age, and these toward the north are in part covered by flows of Tertiary and post-Tertiary lavas. Inyo and Mono counties lie to the east of the Sierra. The metamorphic slates and limestones of this region are for the most part Triassic, though the Jurassic is probably also represented, and are covered to a great extent by volcanic rocks. Mr. Gilbert has shown that the eastern edge of Inyo county reaches the Palæozoic area.

The Jura-Trias strata extend to the east of the Sierra about as far as longitude 117° 30′. They rest directly upon Archæan schists and granite, and the long interval of time which they represent seems to have been extremely quiet, for no non-conformity has been detected in the series. At the close of the Jurassic, however, the whole area from the western foot of the Sierra to the middle of the state of Nevada was raised above the ocean and compressed from west to east, resulting in the formation of a number of parallel ranges, of which the most westerly were the Sierra Nevada and the Blue Mountain range of Oregon. Ore deposits occur on the eastern as well as on the western flank of the Sierra, but their character and mode of occurrence differ from those prevailing in the gold belt.

The Coast ranges, or the western mountainous belt between Mount Shasta and fort Téjon, are for the most part composed of more or less altered rocks of Cretaceous and Tertiary age. The geologists and the paleontologists of the state survey divided the Cretaceous into lower and upper, and, while recognizing the later divisions of the Tertiary, failed to find anything certainly corresponding to Eocene. Of late, however, it has been shown that the fossils of what had been considered as the Upper Cretaceous exhibit strongly marked Tertiary affinities, and it seems by no means impossible that the beds in question, which are sometimes called the Téjon group, and include the Monte Diablo coal-fields, really represent the Eocene. Considering that differences of climate must always have existed, whether more or less marked than those of the present time, it is not strange that doubtful cases like those of the Téjon group, the Laramie beds, and the Australian coal-bearing rocks occur, but rather that it is so often possible to determine the correspondence of strata in widely separated areas.

Though the Coast ranges here and there show granitic rocks, granite is of only local importance, and does not appear to form the central mass, as is the case with the Sierra. The body of these ranges is made up of crumpled and fractured strata, indicating, according to Professor Whitney, sharp and sudden elevations and depressions, extending through the Pliocene epoch. To the southward the prevailing rocks are Tertiary, but north of the bay of San Francisco these almost disappear, the Cretaceous becoming predominant. Volcanic rocks are not widely spread, most of the known occurrences being found between San Francisco and Clear lake.

It appears, therefore, that the elevation of the coast as a whole was comparatively recent. While the quartz veins were forming, and while the gravels were accumulating on the west flank of the Sierra, the region of the Coast ranges and the Great Valley were wholly or partly under a gulf or sea, shallow in parts and surrounding more or less extensive islands. The existence of this shallow sea must have had an important influence on the climate of the Sierra, for, supposing the evaporation to have been the same, nearly the whole amount of moisture now distributed through the Coast ranges and the interior of California would have fallen on the Sierra in addition to its present rainfall. But evaporation is considerably more rapid from shallow seas than from deep ones, and the rainfall on the Sierra must consequently have been enormous. The chief uplift of the Coast ranges took place at the close of the Miocene, and the great metamorphism and ore deposition are probably for the most part referable to the same period, though it is likely that the still later volcanic eruptions induced a portion of them. The Pliocene or post-Pliocene disturbances were comparatively gentle, but Professor Whitney regards the break at the Golden Gate, the prevalence of volcanic rocks from that point north to Clear lake, and the disturbances of the Pliocene south of San Francisco bay, as connected phenomena.

The region south of fort Téjon has been much less investigated than the central portion of the state. It appears to possess some extremely interesting geological features, but also to present unusual difficulties. The San Gabriel range north of Los Angeles has a granitic axis, and it is possible to trace this granite ridge uninterruptedly through Los Angeles, San Bernardino, and San Diego counties into Lower California, and along the peninsula to within a few miles of the old mission of Santa Gertrudis. (a) The sedimentary rocks accompanying this granite ridge are for the most part highly metamorphosed, and are frequently penetrated by dikes of granite. They are nevertheless considered by both Professor Whitney and Mr. Gabb as of Cretaceous and Tertiary age, and the uplift is referred, like that of the Coast ranges proper, to the close of the Miocene.

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a *Geological Survey of California*, ii, 137.

Besides the bitumen springs of Ventura and Los Angeles counties, there are gold mines in this southern California range, but few details have been published as to their occurrence, and their geological relations are still to be studied.

The character of the rocks of the Coast range shows that the Cretaceous and Tertiary sea near the present coast was shallow, but there is evidence that the Great Valley represents a former depression of immense depth. This, however, would not prevent the gulf at the foot of the Tertiary Sierra from being as warm, for example, as the Gulf of Mexico, for the temperature of the water of a land-locked basin depends on the depth of the inlet to it, and if this is small the water of the basin will be warm.

In Russia and Australia the Silurian is the gold-bearing formation, and Sir Roderick Murchison enunciated the somewhat rash generalization that gold was to be looked for only in the Palæozoic. In California it is amply proved by rare but characteristic fossils that the gold-bearing sedimentary rocks are Mesozoic. Generalizations similar to Murchison's have been attempted with reference to ores of other metals, but the simple fact seems to be that eruptive activity or metamorphism is usually a concomitant of the concentration of ores in veins and other allied deposits, and that the older the rocks the greater the general probability that they will have been subjected to action of this description. In the search for coal the fact that the important deposits of the best character are confined to one formation has been of great economical value. The geological indications accompanying the occurrence of veins are to be sought, not in the age of the rocks, but in evidences of disturbance and of certain kinds of decomposition of the surrounding country. The decomposition or alteration of rocks in the neighborhood of ore deposits has been but little studied by geologists until lately, for very sufficient reasons; but of the fact of a connection between it and the deposition of ore California affords excellent examples. The "bed-rock" or auriferous slates of the gold belt is characteristically altered, and the metamorphic stratum in which cinnabar occurs are at once recognized by those familiar with them as "quicksilver rock".

The belt of metamorphic rocks which incloses the greater part of the gold-quartz veins of California is insignificant in width and of little industrial importance south of the southern boundary of Mariposa county. To the north of that line, however, it suddenly widens. Passing northward, the breadth of the belt is stated at about 25 miles in Tuolumne county, 24 miles in Calaveras, 12 in Amador, and 30 in El Dorado. In Placer it is not well exposed, being covered by gravel and volcanic rocks. North of Placer county the metamorphics occupy most of the western slope of the range for a considerable distance, with occasional irregularly distributed patches of granite, but in Butte county the edge of the great lava fields, which occupy much of the surface of northeastern California, are encountered, and cut off the central mining region. The same gold-bearing series seems to reappear in the northwestern counties, but its character and relations are less well understood, and its industrial importance is smaller than in central California.

As illustrative of the structure of the gold belt, Professor Whitney describes in some detail the important portion lying between the Merced and the Stanislaus rivers. Starting from the west, or at the bottom of the Sierra, the first rock encountered is horizontally stratified and undisturbed Tertiary sandstone. To this succeeds the belt of Mesozoic metamorphics in nearly vertical strata. The lower edge is composed of talcose and chloritic slates, weathering irregularly, and locally known as "grave-stone" slates. Next comes a wide belt of a dark-grayish green, somewhat porphyritic, material, which shows a sheeted structure, though not the fine lamination of clay slates. This was known to the state survey as "porphyritic green slate", but Professor Whitney and Mr. Wadsworth are inclined to regard it as a metamorphosed diabasitic tufa. This belt incloses another of argillaceous slate, carrying Jurassic fossils, with which is associated the "mother lode", or the "great quartz vein". Accompanying the argillaceous slate and the mother lode is a band of serpentine. (*a*) In the southern portion of this section the serpentine is confined to the northeast side of the argillaceous slate, but near the Stanislaus river it widens out, occurring in irregular patches and on both sides of the slates.

The strike of the metamorphosed rocks is, as a whole, parallel to the trend of the Sierra, but there are many sharp deflections. The dip of the slates in the southern and central portion of the gold belt is nearly vertical, and usually to the northeast; but in the northern portion, where the belt widens out, the dip becomes irregular, and over wide areas is to the west, becoming flatter as the distance from the crest of the range increases.

Though not confined to the argillaceous slates, or even to the metamorphic strata, the gold-quartz veins of California are more frequent and richer in the argillaceous slates than elsewhere, many fine veins beside the "mother lode" occurring in it. The veins are usually parallel to the stratification, as the following quotation shows: (*b*)

> A very heavy quartz vein passes a little south of Big Oak Flat, Tuolumne county, cutting the strata of slate in which it is contained at a small angle, the lines of bedding of the wall-rock appearing to run nearly northwest and southeast, while the vein of quartz has a strike of N. 30° W.; it dips to the east at an angle of 30°, the slates themselves standing nearly vertical. This is, perhaps the most marked instance hitherto observed in the state of a heavy quartz vein differing essentially both in dip and strike from the inclosing rocks.

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a The origin of serpentine is a disputed point. If it is a fact, as eminent mineralogists have maintained, that it occurs as an alteration of hornblende and pyroxene as well as of olivine, there appears to be no difficulty in accounting for its presence in metamorphic rocks. Chlorite and serpentine, however, are occasionally confounded.

b *Geological Survey of California:* Geology, vol I, p. 237.

The most remarkable primary metalliferous deposit of California is the mother lode already referred to. Many of the great mines of the state are upon it, and others are in its immediate vicinity on veins which most likely have an intimate structural connection with it. It extends from a point a few miles southeast of the Merced river, in Mariposa county, to near the center of Amador, a distance of about 80 miles. Though the croppings are in places hidden by overlying rock or detritus, they are visible for a great portion of the distance at such frequent intervals that the identity of the lode is not doubtful. It is more than probable that it extends to the north of the point indicated, but it cannot be traced with absolute certainty.

This powerful lode (*a*) is made up of irregularly parallel plates of white compact quartz and crystalline dolomite or magnesite (*b*) more or less mixed with green talc; and these plates, which somewhat resemble the "combs" of ordinary lodes, are either in contact or separated from each other by intercalated layers of talcose slate. The quartz is chiefly developed in the central portion of the vein; and, from its color and resistance to decomposition, it gives rise to a very conspicuous outcrop, forming the crest of the hills, so that it can be readily seen from a distance of several miles. The dolomitic or magnesitic portion decomposes somewhat readily, and it becomes a kind of "gossan" or cellular, ferruginous mass, of a dark-brown color, often traversed in every direction by seams of white quartz. The quartz is the auriferous portion of the lode, although it is far from being uniformly impregnated with gold. Most of the mines which have been worked between the Merced and the Stanislaus are on the northeast side of the great quartz vein, either in contact with it or in some parallel band of quartz subordinate to or at a little distance from it. The talcose-slate bands in the vein are often themselves more or less auriferous.

Professor Whitney does not regard it as by any means proved to be a fissure vein, or even an exclusively segregated one; on the contrary, it seems to him most likely the result of metamorphic action on a belt of rock of peculiar composition, and perhaps originally largely dolomitic in character.

Besides the quartz veins in the metamorphics of California, there are also many in the granites of the same region. Though of less importance than those in the sedimentary rocks, many of them have been worked with profit, but no careful comparison has been instituted between the two classes of veins. In some instances at least, and when near the slates, the veins in the granite are parallel to the stratification of the metamorphic rocks, and are also essentially gold veins. It is probable, however, that on closer investigation they will be found to present characteristic differences.

Gold never occurs in nature unassociated with silver, and silver, it is said, is never wholly free from gold; but there seems, nevertheless, to be a natural distinction between gold veins and silver veins. In Nevada, Arizona, and throughout Mexico gold usually occurs only in minute particles entangled in sulpho-salts of silver and other metals, except near the surface, where atmospheric action has decomposed the original matrix. Though the value of the gold in such cases sometimes equals or exceeds that of the accompanying silver, the latter usually greatly surpasses it in weight. In the gold belt of California, on the other hand, the gold occurs in great part as flakes or even as masses, often not immediately in contact with sulphides, and carrying in alloy only 0.100 or 0.200 of metallic silver. As a rule, the gold does not assume a crystalline form in the California mines, but more or less perfect octohedral forms have been found at Spanish Dry Diggings and at Byrd's valley. Cubical crystals have not until lately been observed, and Professor Whitney notes that he has neither seen nor heard of any in the state. (*c*)

Sulphides always accompany the gold in the veins, though these minerals are not always found in contact with the larger particles of the metal. So general is the association, however, that when, as is often the case even with rich quartz, the gold is not visible to the naked eye, miners judge of the value of the ore by the quantity of sulphurets. Quartz with plenty of sulphurets and no visible gold often occurs in large bodies, and is apt to pay better in the long run than ore with very coarse gold, or "specimen quartz", as it is called by the miners. The minerals embraced under the term "sulphurets" are considerable in number, but the most common are pyrite, mispickel, zincblende, and galena. Though seldom containing the greater part of the gold, it is rarely that the sulphurets do not include a portion of the metal in such a way that it cannot be extracted by amalgamation. Concentration of the sulphurets, followed by chloridation, is then the readiest means of extraction. There is an occurrence of cinnabar in gold quartz veins inclosed in slate in Calaveras and one in Mariposa.

The distribution of gold in the veins is usually very irregular, and while on some veins it will pay to extract the ore from wall to wall, in most cases certain belts or chimneys of rock only are remunerative.

Had the veins been deposited in the slates before they were raised into their present position in post-Jurassic times, they must have been much faulted and broken. This is not the case, nor is it probable that veins could have formed in undisturbed strata. On the other hand, there can be no doubt that the auriferous gravels have been formed at the expense of eroded croppings of the quartz veins; and the veins, or most of them, must therefore have been deposited before the gravels. These, according to Professor Whitney, were accumulated during the whole of the Tertiary period, while Cretaceous gravels appear to be entirely absent. The range was above water during

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a Professor Whitney: *Auriferous Gravels*, p. 46.

b In the only specimen which has thus far been chemically examined the supposed dolomitic portion proves to be an intimate mixture of quartz and magnesite.

c In December, 1882, however, Mr. James Terry purchased a specimen of gold from Louis Abraham, Kearney street, San Francisco, which is said to have come from Eldorado county, between Plumas and Placerville, which shows a number of fine cubical crystals with full faces and sharp edges. The same specimen also shows well-developed dodecahedrons, trapezohedrons combined with the cube and octohedron, a cube the corners of which are truncated by a trapezohedron, and possibly other combinations.

the Cretaceous, and such fresh-water deposits as accumulated on its west slope seem to have been swept away during the succeeding period. The natural inference would seem to be that the formation of the veins occurred between the end of the Jurassic and the beginning of the Tertiary, and that it was intimately connected with the upheaval of the Sierra and the metamorphism of the strata of preceding epochs.

Substantially coincident with the area of gold veins is that of the auriferous gravels of California. In the gold-bearing regions of all countries secondary deposits of the metal, associated with gravel or sand, have played a large part, because the gold may be separated from such loose material at a low cost. In California, however, the gravels have proved particularly important because of the invention and development there of the peculiar system of hydraulic mining, which consists in washing the gravels into sluices provided with quicksilver by the aid of powerful jets of water. The great importance of this system is due to the fact that it is among the least costly methods of handling material, if it is not the very cheapest known. It costs under favorable circumstances but five cents per cubic yard, or, say, three cents per ton, and sometimes even less. It thus renders deposits of gravel valuable which under most conditions would be absolutely worthless. Several conditions, however, are necessary to the successful prosecution of hydraulic mining, among which the most important are a deep gravel bank, abundance of water with a great head, and some available valley at a lower level than the bank, into which the gravel from which the gold has been extracted may be washed. The topographical and climatic conditions in the Sierra are peculiarly favorable for this process, while in Australia, where gravel is abundant, circumstances rarely permit the application of this method of extraction.

The gravel consists of bowlders and pebbles of various rocks, with silt, clay, and volcanic ash. The gold occurs as nuggets and fine particles, free or nearly free from rock, but also as fragments of gold quartz, and is accompanied by a variety of other heavy substances, as magnetite, garnet, and zircon; rarely and locally also by cinnabar, platinum and iridosmine, diamonds, native copper, and other substances of high specific gravity. One of the striking features of most deep gravel banks is the so-called "blue lead". This name is applied to the lower portions of banks, which are generally somewhat closely compacted and possess the color of the blue clays occurring all over the world. Although the "blue lead" has led to wholly untenable theories as to the character of the gravel deposits, its nature is very readily accounted for. Loose materials near the earth's surface are everywhere impregnated with a small amount of organic matter carried down from the surface by water and filtered from it by the porous strata. This organic matter, in the absence of free oxygen, exercises a slow but inevitable reducing action on ferric oxide and on some ferric compounds, and gives the soil the bluish color characteristic of the presence of iron in the ferrous state. Close to the surface, however, oxygen, either gaseous or in aqueous solution, more than counterbalances the reducing action of the organic matter, and above a certain line the gravel is consequently reddened by ferric oxide. In shallow deposits the gravel is usually reddened to the bottom, but of course this does not necessarily imply that such gravels have a different origin from those of a bluish tint.

To a very large extent the deep gravels are covered by a capping of volcanic material, sometimes as solid black basalt, and sometimes as loose volcanic "ash"; and while some banks are not thus covered, these are rarely at any great distance from volcanic capping. The volcanic material has protected the gravels in many cases from erosion, but there is also a connection in their deposition. The gravels occur in ancient river beds, which formed the natural channels for the flow of lava as well as of water. Volcanic eruptions occurred during the period of the gravel formation, as well as at its close, and sheets of ash or even of solid lava are found in the banks as well as upon them. When the lava cap is thick and solid the gravels can only be mined by drifting, and are not workable by the hydraulic process.

Besides the deep gravels, which date from a period prior to the volcanic eruptions, there are many accumulations of recent origin. The bars of the present river system have yielded great quantities of gold, and there are many shallow placer deposits which are no doubt due to the modern erosion of quartz croppings, while others are a consequence of the erosion of older gravels. The modern gravels, however, are trifling in quantity as compared with the older deposits. Some of the shallow placers are no doubt mere remnants of deeper Tertiary gravels which have not been wholly carried away by the erosion of the present epoch.

The bed-rock of the gravel deposits varies in character, being either limestone, granite, or metamorphic slate; but the last is the rule, and few important deposits occur far from the slate bed-rock, which, as has been explained, is the main, though not the exclusive, habitat of the gold veins. In nearly all cases the gravel rests in local depressions, early recognized by the California miners as the beds of former streams. Many of the gravels, it is true, are high above the present drainage system, and even form the tops of hills; but this is due to the erosion of the present stream-beds, which have been cut down to a great depth since the gravel period. The bed-rock is usually rough, consisting of nearly vertical slates, and the natural crevices, or "riffles", large and small, thus formed often contain extremely rich gravel. As might naturally be supposed, the greater part of the gold is generally found near the bed-rock, for as gold is about seven times as heavy as ordinary rock every disturbance of a gravel bar in a stream tends to shift the gold to a lower level. Sometimes, however, rich gravel is again deposited over a comparatively firm stratum in the gravel, and occasionally gold is quite uniformly disseminated through a whole bank.

An idea has been current in the mining region that by some process masses of gold in the gravel have increased in size. For this there is absolutely no valid evidence. The rounded masses of gold found could not have been deposited from solution in that form or with such a surface. They have been beaten and worn into shape, much as the accompanying pebbles have been formed, the only difference being due to the fact that gold is malleable. Professor Whitney believes it probable that the higher croppings of the gold veins were richer and contained larger masses of gold than the lower portions of the veins still in place, and if there was any difference at all it was probably of that character. As Professor Newberry (*a*) points out, however, the gravels represent vastly more vein-quartz than has been extracted by deep mining, and the proportion of large masses of gold met with in the veins probably bears as great a ratio to the total weight of quartz extracted, as do the nuggets in the gravels to the quartz from which their metallic contents were derived.

The investigations of the state survey have shown that the deep gravels were deposited by rivers which headed in the high Sierra and ran in a westerly direction, emptying into the sea, which, in Tertiary time, occupied the great valley of California. Although all the details of the former river system cannot now be traced out, the courses and relations of the channels developed by hydraulic mining seem to establish this point beyond a question. There were two great rivers in the Pliocene epoch, one corresponding to the American and the other to the Yuba; but the Bear river of that time probably emptied into the American at a considerable height above the valley.

The gravels cannot possibly have accumulated under the present conditions of precipitation. A far greater erosive power than that exhibited by the California streams of to-day must have been exerted at the time in question, as no one can doubt who has ever visited the gold belt. For a long time past the present rivers have merely been deepening their narrow courses, and when freshets occur they merely serve to sweep the cañons clear of *débris*, but cannot alter the course of the stream. The width of the old channels, as well as the character of the deposits, shows that the old rivers were tumultuous streams of great volume, which frequently burst their bounds and formed new beds.

The evidence of enormous erosive power during the deposition of the gravel has been so apparent to all observers that some of them have called in the action of great glaciers to account for the occurrence of the deposits. According to Professor Whitney this is incorrect; indeed, he holds that the former glaciers of the Sierra did not come into existence until after the greater part of the gravels occupied their present position. The bed-rock which the gravels cover, and which they have protected not only from erosion but even from atmospheric action, shows no traces of glacial polishing and scratching. This is in marked contrast to the higher regions of the range, where the glacial markings are almost as fresh as in the Alps. Nor are occurrences frequent which can possibly be confounded with moraines, while the fossils found indicate, according to Mr. Lesquereux, a climate a few degrees warmer than that of the present time.

Professor Whitney believes the great precipitation necessary to account for the large rivers of the Tertiary in California to have been mainly due to the prevalence of higher temperatures at that period and to the accompanying increased evaporation from the surface of the ocean. It is at least conceivable that the climate should have been something like that of the Khassia hills, upon parts of which the hot winds from the bay of Bengal deposit some 500 inches of rain yearly. The presence of a sea at the foot of the range must have largely increased the rainfall, as has been pointed out. It is to be inferred from Professor Whitney's remarks that he supposes the climate of the Sierra to have been too warm for glaciers during the Tertiary. He regards the present climate, on the other hand, as too dry to permit of their formation, though there can be no doubt of their existence in the higher part of the range above the gold belt up to within a comparatively short time. A few small glaciers on the northern slopes of mount Shasta are now the only remnant of the former ice system of the state. The Sierra glaciers were of the mountain type, however, comparable at their greatest extension with those of modern Switzerland, and nothing like a general glaciation or a diluvial period ever existed in California.

The following sections of auriferous gravel deposits are selected from a large number furnished by the reports of the special experts to illustrate the mode of occurrence of the gravels in various portions of the state:

BONANZA MINE.

MOKELUMNE HILL DISTRICT, CALAVERAS COUNTY, CALIFORNIA.

I	Lava cap in places.	Maximum, 125 feet; average, 75 feet.	Richest portion usually lower 15 feet above bed-rock. In places gold nearly evenly disseminated throughout deposit.
II	Alternating fine and coarse sand with pebbles (chiefly quartz)		
III	Cement. A quartzose (also granitic and slaty) conglomerate, cemented with sesquioxide of iron.		
IV	Bed-rock, slate.		

The ancient channel on which this mine is located is traceable, with intermittent breaks, for 10 miles. The channel is 500 feet wide, the outer edges barren, and the pay channel is 300 feet wide.

a School of Mines Quarterly, November, 1881.

LAGRANGE HYDRAULIC MINE.

LAGRANGE DISTRICT, STANISLAUS COUNTY, CALIFORNIA.

I	Red sand	Maximum, 300 feet; average, 40 feet.	
II	Coarse red gravel, containing pebbles of granite, etc.		
III	Red cement ("hard-pan")		
IV	White siliceous clay		
V	Red cement (same as III)		
VI	Sand with pebbles		
VII	Loose yellow sand		
VIII	Dark-colored gravel, containing *débris* of granite, argillaceous slate, "serpentine," etc., with some quarts.		Lowest 6 feet 8 inches richest.
IX	Bed-rock at Lagrange "diorite and slate"; at Patrickaville "basaltic tufa" (no specimen).		

Quarts forms but a small proportion of the gravel, which is chiefly granite, etc. Generally the upper workings do not pay, 90 per cent. of the gold being obtained from near the bed-rock; but sometimes the upper horizon is the richest. At Patrickaville, gravel is overlaid by tufa; not much tufaceous cropping at Lagrange. Ancient river bed. Deposit in patches for 1 mile wide by 2½ miles long.

LYON DRIFT MINE.

PLACERVILLE DISTRICT, EL DORADO COUNTY, CALIFORNIA.

I	"Lava" or a consolidated sediment of volcanic origin	60–130 feet.	
II	Mountain gravel	0–50 feet.	
III	Granitic sand, in places consolidated	0–20 feet	
IV	Gravel	Maximum, 20 feet; average, 3½ feet.	
V	Bed-rock, slate.		

Three benches of ancient river, overlaid with volcanic matter, 60 to 130 feet wide, are here traceable for 3,000 feet.

ORION MINE.

IOWA HILL, PLACER COUNTY, CALIFORNIA.

I	Sand and fine gravel	Maximum, 180 feet; average, 100 feet.	All pays. Richest near bed-rock.
II	Coarser blue gravel		
III	Bed-rock, black slate, rough.		

No lava; no quicksand. Ancient river bed, said to be 2,000 feet wide, traceable 2½ miles.

VAN EMMONDS' MINE.

MICHIGAN BLUFFS, PLACER COUNTY, CALIFORNIA.

I	Very little lava.	Maximum, 50 feet; average, 30 feet.	All pays; but white gravel nearest bed-rock best.
II	Fine gravel, alternating with sand strata		
III	Blue gravel		
IV	White gravel		
V	Bed-rock, rough slate		

Petrified wood, leaves of oak, pine, etc., found in sand strata. It is unusual to meet white gravel beneath the blue.

MORRIS RAVINE MINE.

MORRIS RAVINE DISTRICT, BUTTE COUNTY, CALIFORNIA.

I	Hard, solid lava cap in places.			
II	Fine quarts gravel		Maximum, 150 feet; average, 40 feet.	A little gold throughout. Blue gravel richest.
III	Rotten bowlders			
IV	Blue gravel	3–30 feet.		
V	Bed-rock, chloritic and clay slates, rough and decomposed.			

Pipe-clay occurs irregularly throughout deposit. Quicksand met with.

SPRING VALLEY MINE.

CHEROKEE DISTRICT, BUTTE COUNTY, CALIFORNIA.

I	Lava cap over part of claim.			
II	Fine quarts gravel	25–150 feet.	Maximum depth, 400 feet; average, 200 feet.	Best pay in III and IV on bed-rock.
III	Rotten bowlders of yellow slate mixed with quarts gravel	5–15 feet.		
IV	Blue gravel	15–80 feet.		
V	Bed rock, where exposed, described as "basalt" like the cap, probably metamorphic. Surrounding country rock is slate.			

Water and quicksand found in large quantities at the depth of 300 feet. Barren pipe-clay, 25 to 150 feet in places, as a rule overlying rich gravel.

HUNGARIAN HILL MINE.

PLUMAS COUNTY, CALIFORNIA.

I	Soil	Maximum, 110 feet; average, 75 feet.	Gold throughout gravel. All pays.
II	Loose gravel, same character from surface to bed-rock		
III	Generally soft slate bed-rock; in places hard siliceous slate. Rough, with projecting points in some places rising nearly to surface.		

River bed, with rim-rock on each side, 250 feet wide; traceable, 3¼ miles. No lava, water, or quicksand.

CARROLL DRIFT MINE.

McADAM'S CREEK DISTRICT, SISKIYOU COUNTY, CALIFORNIA.

I	Loam	4 feet.	Maximum, 115 feet; average, 73 feet.	None barren, but only a small portion pays for drifting. The pay streak is 200 feet wide and length of claim.
II	Loose tailings	6 feet.		
III	Wash gravel, with clay and sand	10 feet.		
IV	Compact yellowish-white clay (water level)	18 inches to 4 feet.		
V	Coarse yellowish gravel (bulk of deposit)			Good pay.
VI	Quartzose matter	3-6 inches.		
VII	Greenish gravel	12 feet		Best pay on bed-rock and in bed-rock to a depth of 2 feet.
VIII	Bed-rock, rotten brown slate and hard fine-grained blue slate.			

Bed of McAdam's creek. Mining is carried on over a length of 3¼ miles by a width of 150 to 600 feet.

OAK GROVE DRIFT MINE.

McADAM'S CREEK DISTRICT, SISKIYOU COUNTY, CALIFORNIA.

I	Loam	4 feet.	Average, 65 feet.	None of the gravel is barren.
II	Loose tailings	6 feet.		
III	Wash gravel, with clay and sand	10 feet.		
IV	Compact yellowish clay (water level)	18 inches to 4 feet.		
V	Coarse yellow gravel			Good pay.
VI	Quartzose matter	4 to 6 inches.		
VII	Yellow gravel			The best pay is 1 to 3 feet on bed-rock and 1 to 3 feet in bed-rock.
VIII	Bed-rock, brown slate, ridgy and seamy in places; in others soft and open.			

PACIFIC MINE.

HUMBUG DISTRICT, SISKIYOU COUNTY, CALIFORNIA.

I	Loose wash gravel	5 feet.	Maximum, 50 feet; average, 45 feet.	Contains but little gold.
II	Coarse yellow gravel, containing many large bowlders	8 feet.		
III	Fine sand	6 inches to 2 feet.		None barren.
IV	Yellow gravel	20 feet.		
V	Dark yellow gravel	1 foot.		
VI	Blue gravel	8 inches to 10 feet.		Best pay.
VII	Bed-rock, blue slate.			

River bed traced for 1 mile, average 50 feet wide.

BUNKER HILL MINE.

DEL NORTE COUNTY, CALIFORNIA.

I	Red loam mixed with fine gravel	15 feet.	Maximum depth of bank, 125 feet; average, 80 feet. Maximum depth of gravel, 50 feet; average, 30 feet.	None of the gravel is barren, but the richer portion is near bed-rock.
II	Loose gravel	15 feet.		
III	Gray cement streak, 60 feet wide. Large bowlders in best ground	20 feet.		
IV	"Serpentine" bed-rock easily piped, having blue slate under it (Leavens). Specimen determined as highly metamorphic dioritic-looking rock.			

Channel one-half to three-quarters of a mile, 150 feet long; course a little west of north.

Large deposits of copper ores have been found in the auriferous slate series, especially in Calaveras county. Copperopolis is the principal point, but there are also deposits at Campo Seco, and again further north near Ione City. Prospects have also been found on the same line beyond this point. The ores are native copper and carbonates near the surface, replaced by a mixture of iron and copper pyrite below the water-line. The deposits have the same dip and strike as the inclosing chloritic slates. Extensive shipments were made in former years.

Mono and Inyo counties, though politically united to California, considered from a physico-geographical point of view, form a portion of the Great Basin. The sedimentary rocks of Mono county appear to be Mesozoic, but the western edge of the great Palæozoic area which covers the eastern portion of the Great Basin crosses the California line about due south of Columbus, Nevada, passing near Owen's lake and then diverging to the southeast. Great quantities of lava are met with in both counties, as throughout the Great Basin. The deposits of these counties also

bear a much closer resemblance to those of Nevada than to those of central California. The best known mining localities are Bodie, Cerro Gordo, and Panamint, but none of them have formed the subject of any detailed geological investigation.

The bullion of Bodie is usually regarded as gold, because its silver contents are much less valuable than the accompanying gold. Reports made to the director of the mint for the year 1880 show that from 5 to 63 per cent. of the value of the bullion produced by the various mines was silver, which also formed 17.91 per cent. of the value of the total product ($3,063,699 13). It follows that from 45.7 to 96.5 per cent. of the weight of the bullion from different mines and 77.72 per cent. of the total weight was silver. In 1879, when a smaller portion of the colorados were worked out, silver only formed 65.2 per cent. of the entire weight. Bodie metal may therefore very properly be regarded as a highly doré silver bullion, similar to that of the Comstock lode, and as essentially different from that of the gravel and slate region ordinarily known as the gold belt.

The Comstock was at first worked for gold. The Bulwer, the Syndicate, and the Standard Consolidated, which show but little silver, are on top of a hill where the water-level is far from the surface and the quartz is reddened to a great depth; the Bodie Consolidated, Noonday, and others are at lower elevations. The sulphurets of these mines are not oxidized, and the bullion shows a large amount of silver.

The gangue minerals of these deposits are base sulphurets, quartz, and calc-spar. They are inclosed in extremely decomposed rock, bearing clear signs of solfataric action. The rock is so highly altered that tolerably fresh specimens are not obtainable near the mines. Slides of the freshest specimens collected are not decisive as to the character of the rock. They show plagioclase, and apparently some orthoclase, accompanied by mica and a little hornblende; the ground mass also contains quartz. Only a detailed examination in the field will decide what name the rock should bear.

The mines of Cerro Gordo were not in operation during the census year. The deposits, which at one time were very productive, were masses of argentiferous lead ores occurring in limestone, and consisting for the most part of carbonate, sulphate, and other decomposition products of galena. Schists and slates were also met with in the mines, as well as a granite-porphyry. This is said to occur as a dike in the Union mine and elsewhere, and is locally called syenite, though it is quartzose and micaceous. Panamint was for a short time a very flourishing camp, its prosperity being derived from veins in limestone carrying chiefly argentiferous gray copper ore or freibergite, associated with galena and zincblende. Mining is still being carried on, but the richer deposits were soon worked out. The age of the limestones of Cerro Gordo and Panamint is unknown. Both districts lie near the contact between the Palæozoic and the Mesozoic, and may belong to either; but limestones are exceptional in the Trias and Jura of the Sierra region, while they predominate in the Palæozoic area.

Gold has been found at a great number of points in the Coast ranges proper and in the western ranges of southern California. No doubt large individual profits have been made at certain localities, and it is by no means impossible that as good or better veins than those found await discovery. It is scarcely likely, however, that after thirty years of skillful prospecting any important gold-mining region has escaped observation. A few years since great hopes were raised by the prospects on veins in the slates and on the contact between slates and granite in the Julian and Banner districts near San Diego, but they have fallen short of the expectations excited.

The so-called Gold Bluffs along the coast of the northern counties, especially near the mouth of the Klamath river, are bluffs which contain extremely small quantities of gold, and seem to be beds of detritus left by the shifting of the river channels. The sea encroaches upon them, and when the surf strikes the beach in certain directions and with a certain strength the gold is concentrated in comparatively rich sands, which are gathered and treated in apparatus of various designs by amalgamation.

The only quicksilver ore of great importance is cinnabar, although metacinnabarite, the black sulphide, is rather abundant in a few mines, and metallic quicksilver sometimes accompanies the deposits of its compounds. The metacinnabarite described by Dr. G. E. Moore was amorphous, but according to Mr. Goodyear it also occurs as minute crystals. Cinnabar is found in a great number of localities in the Coast ranges for 100 or 150 miles north and south of San Francisco, always, so far as known, in metamorphic rocks of Cretaceous age. The character of the metamorphism is generally peculiar, and the so-called quicksilver rock is readily recognizable. It is a silicified chert like material, often reddened by iron oxide, and usually accompanied by serpentine or serpentinoid matter. In almost all cases pyrite or marcasite and bituminous matter accompany the cinnabar, and mispickel and copper pyrite are reported in a few instances. At Sulphur Banks, on Clear lake, native sulphur occurs in great quantities with the quicksilver ore, and native gold has been found in water-worn masses of cinnabar not far from the same locality. The converse occurrence of cinnabar in two of the quartz veins of the Sierra gold belt has already been noticed. Stibnite is reported as occurring with cinnabar at the Lake mine near Knoxville. The usual gangue minerals are quartz, calcite, and magnesite.

Cinnabar does not occur in well-marked veins, but generally in irregular bodies distributed through the rock. In the New Almaden mine, which has been much more extensively worked than any other in the state, these bodies appear, from a model constructed by the owners, to lie on a curved surface, indicating a geometrical relation between the positions of the several ore-bodies, though an obscure one. At this mine the masses of ore are usually connected by tiny seams of the same material. There is a strong similarity between this mode of occurrence and that of many lead-ore deposits in limestone, and it may be that the problem of their true character is the same.

The quicksilver country north of San Francisco is a volcanic region, while to the south volcanic rocks are subordinate in some localities and wanting in others. To the south, too, there is no indication of any recent deposition of the ore, while to the north deposition is still actually in progress. No general inference as to the genesis or the age of the deposits can therefore be drawn without further investigation, while the great similarity in the association of minerals suggests a similar origin for most of them.

The Sulphur Banks, on Clear lake, forms the subject of a recent paper by Professors Le Conte and Rising. (a) At that point cinnabar with pyrite and some bituminous matter, as well as free sulphur, is now being deposited. The hot waters rising to the surface are charged with sulphides of ammonium and of the fixed alkalies, and appear to carry in solution cinnabar and pyrite, which are deposited, in the opinion of the authors, by reduction of temperature and pressure, probably assisted by neutralization through the percolation of free sulphuric acid from the surface. The deposition of sulphur is a surface phenomenon. It may also have attended the formation of the deposits to the south of San Francisco and have been subsequently removed by erosion.

The only Californian coal-fields of great importance are those near Monte Diablo, which occur in sandstones of the Upper Cretaceous or Téjon group. According to Professor S. F. Peckham's examination, (b) these coals carry from 5 to 11 per cent. of ash, 4½ to 5¼ per cent. of sulphur, and from 11½ to 13 per cent. of water. The refuse dumps of these mines frequently take fire spontaneously from the oxidation of pyrite. Coal of the same age occurs under less favorable conditions at Corral Hollow, in the Monte Diablo range. Seams are found here and there all along the Coast ranges, but they are usually thin, and even when of a workable thickness are so faulted and broken as to be of small value.

Lignite of Pliocene age is found at Ione valley, Amador county, and is used along the line of the railroad to some extent at Dog creek, near the Truckee river.

In southern California there are vast quantities of bitumen, from which asphalt and a certain quantity of illuminating oils are obtained. The bitumen occurs in shales of the Miocene, which are in large part too much disturbed to permit of the accumulation of pressure necessary to induce flowing wells. Many of these bitumens, though thin as they issue from the ground, oxidize and are converted into hard asphalts. According to Professor Peckham, the California bitumens are composed of a different series of hydrocarbons from those which make up the petroleums of Pennsylvania.

AMADOR COUNTY.

This county lies directly across the main gold belt. Quartz mining takes the first rank, though there are gravel deposits, and hydraulic mining is carried on to a considerable extent. The gold in the veins is associated with iron and copper pyrite, marcasite, mispickel, and small quantities of galena. The gangue is chiefly quartz, but some calcite is occasionally found in the veins. The country rocks are slate and granite, the former being predominant, but a greenstone also occurs, which, though much decomposed, is probably a diabase or proterobase. The mother lode has been traced with certainty from Mariposa to about the center of Amador. Copper is found in the western portion of the county, but it is not at present worked, and a lignite occurs at Ione City which is of considerable local importance.

AMADOR.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
AMADOR CITY.				
Keystone	(Gold, chalcopyrite, galena), pyrite and quarts	Proterobase (?)*	Proterobase (?)*	Vein.
JACKSON.				
Monte Richard	(Gold), iron-stained quarts	(Greenstone or augite-porphyry, called granite.)	Proterobase	Vein.
Oneida	(Gold, galena, chalcopyrite, and marcasite), pyrite and quartz.	Greenstone, probably an augite-porphyry.	....do.....	Do.
Zelle	(Gold, pyrite, rarely galena and chalcopyrite, quartz).	(?)	Quartzite	Do.
PLYMOUTH.				
Pacific Mining Company (Empire, etc., mines).	(Gold), indeterminable black sulphurets and quartz			Vein.
SUTTER CREEK.				
Consolidated Amador	(Gold, galena, chalcopyrite, mispickel), pyrite and quartz.	(Clay mica slate)	(Talcose slate)	Vein.
VOLCANO.				
Madeira	(Gold), galena, calcite, and quartz.			

* Examined microscopically.

a *American Journal*, vol. 24, p. 23, 1882.

b *Geological Survey of California:* Geology, II, p. 44.

BUTTE COUNTY.

A large part of Butte county lies in the Great Valley, and produces no gold; but the eastern portion contains extensive gravel deposits, which are continuations of those of Plumas and Yuba. Much of the gravel is covered by a cap of basalt, and the bed-rock is, in all the cases reported, sandstone or metamorphic slate.

BUTTE.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
CENTERVILLE.				
Big Butte creek	(Gold gravel)	(Sandstone)	Basalt cap*	Placer.
CHEROKEE.				
Spring Valley	(Gold gravel)	Altered diabase*		Do.

* Examined microscopically.

CALAVERAS COUNTY.

Both quartz and gravel mining are actively pursued in this county, which lies across the gold belt. The auriferous quartz carries iron and copper pyrites, mispickel, galena, and zincblende. The wall rocks in all the cases reported are metamorphic. The mother lode crosses this county. The gravel is of the ordinary character, and, as usual, is accompanied by more or less basaltic lava. Copper deposits occur below or to the west of the gold belt at and near Copperopolis.

CALAVERAS.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mines.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
ANGEL'S.				
Potter Prospect	Gold, galena, and quartz			Vein.
MOKELUMNE HILL.				
Gwin	(Gold, mispickel, zincblende), pyrite, chalcopyrite, and quartz.	(Black slate)	(Black slate)	Do.

DEL NORTE COUNTY.

Auriferous gravels are the chief metalliferous deposits of this county, the bed-rock consisting of slate and other sedimentary strata. Beach sands are also worked to a small extent on the coast.

DEL NORTE.

[NOTE.—Determinations in parentheses are given on the authority of the expert.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
Bunker Hill	(Gold gravel)	Metamorphic dioritic rock		Placer.
China Creek	do	Schist and shale		Do.
Del Norte	do	Slate		Do.
Happy Camp	do	do		Do.
Muc-a-muc	do	Shale		Do.
Wingate	do	Slate		Do.

EL DORADO COUNTY.

El Dorado lies across the gold belt, and contains a great deal of gold quartz, while the placers are comparatively insignificant. Some of them, however, buried under heavy caps of lava, are profitably worked by drifting. The gold quartz carries the usual sulphurets, pyrites, mispickel, and zincblende. The country rock is chiefly slate. Copper ores also occur in the western part of the county.

EL DORADO.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
PLACERVILLE.				
Lyon	(Gold gravel)	Slate	Lava cap, basalt, pumice*	Placer.
Placerville	(Gold, pyrite), talc and quartz	(Greenstone and slate)	(Greenstone and slate)	Vein.
Springfield	Gold, pyrite, mispickel, quartz, (zincblende and galena).	(Slate)	(Slate)	Do.

*Examined microscopically.

FRESNO COUNTY.

Fresno extends from the crest of the Sierra to the Coast ranges. It lies to the south of the main gold belt, but contains a few gold quartz veins in the Potter ridge district and elsewhere, carrying the usual sulphurets, and being inclosed in slates. At the western edge of the county is the famous New Idria quicksilver mine, in which cinnabar is accompanied by pyrite and bituminous matter. According to Mr. Goodyear, the ore does not occur in a vein, at least of the typical character, but in irregular bodies, distributed in metamorphic sandstone and shale.

FRESNO.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
SAN CARLOS.				
New Idria	Cinnabar, (pyrite, chalcopyrite, and bitumen)	Sandstone and shale	Sandstone and shale	Vein.
POTTER RIDGE.				
Fresno Enterprise	(Gold, sulphurets, and quartz)	(Slate)	(Slate)	Do.

HUMBOLDT COUNTY.

There is no gold-quartz mining in Humboldt, and the placer mines are not extensive, compared with those of the central counties. The gravels appear to represent modern river bars of the Klamath, along the banks of which they are found, in some cases, however, at a very considerable elevation above the present stream. As in Del Norte, there are auriferous beach sands, which can be worked with profit when certain combinations of wind and waves have effected a preliminary concentration of the auriferous material.

INYO COUNTY.

The most important mines in this county carry argentiferous lead ores with calcareous gangue. They occur either in limestone or in limestone associated with granite and schist. The deposits are chimneys, or bodies of an irregular form, such as lead ores frequently assume elsewhere. Copper ores, associated with those of lead, also occur. Where copper is the principal constituent the gangue is usually siliceous. The copper veins occur in limestone or in granite, or on the contact between the two. The lead ores are galena, cerussite, anglesite, and probably lead ocher, accompanied by argentite and other silver minerals. The copper ores are chalcopyrite, stromeyerite, tetrahedrite, bornite, and carbonates. They are usually argentiferous. In addition to the gangue minerals mentioned, fluorite is found in the Defiance mine, in a silver-lead deposit between granite and limestone. There are also gold-quartz veins in granite in the county, and some small gold placers. At the Lee mine argentite and horn-silver are reported as occurring in limestone.

INYO.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
CERRO GORDO.				
Ignacio	(Milling ore), quartz	(White limestone)	Schist (white limestone).	
Jefferson	Galena, cerussite, and anglesite	Marble	Marble.	
San Felipe	Polybasite and copper stains and quartz	do	do.	
Union Consolidated	Galena and limonite	do; Granite, porphyry dike*.	do	Vein.
COSO.				
Defiance	Galena, cerussite, chalcopyrite, malachite, fluorspar, calcite, and pyrite.	(Granite)	Siliceous limestone	Vein.
Josephine	(Gold quartz)	do	(Granite)	Do.
New Coso Company (including Lucky Jim and Christmas Gift).	Galena, cerussite, calcite, and (anglesite)	Granite	Limestone (containing barium).	Do.
Mariposa	(Gold, auriferous pyrite, and quartz)	(Granite)	(Granite)	Do.
Phœnix	Cerussite and anglesite	Limestone and schist	Limestone and schist	Bedded vein.
KEARSARGE.				
Kearsarge	Cerussite, micaceous iron, limonite, (tetrahedrite, cerargyrite, and argentite), quartz.	Granite*	Granite*	Vein.
PANAMINT.				
Hemlock	Stromeyerite, (tetrahedrite, galena, pyrite, and zinc-blende), quartz.			
LOOKOUT.				
Modoc Consolidated	(Cerussite, carrying gold and silver, with arsenic and antimony; calcite, iron oxide, and manganese minerals.)	(White limestone)	(Blue limestone)	Bedded vein.
RUBS.				
Brown Monster	(Cerussite, galena, bornite, malachite, pyrite, and quartz.)	(Blue limestone)	(Blue limestone)	Vein.
FISH SPRINGS.				
Golden Wreath	(Gold, auriferous pyrites, and quartz)	Granite	Granite	Flat vein.
Alabama	(Gold quartz)	(Granite)	(Granite)	Vein; also small placer.
Lee	(Horn-silver, argentite, and quartz)	(Limestone)	(Limestone)	Deposits.

* Examined microscopically.

KERN COUNTY.

Kern county lies south of the main gold belt; it nevertheless contains some gold-quartz veins in its northeastern portion, in the Sierra range, as well as some shallow placer gravels.

LAKE COUNTY.

The only important mineral deposits of Lake county are those of quicksilver, which occur at a number of points in considerable quantities, accompanied by pyrite, sulphur, bituminous matter, and quartz. The inclosing rocks are metamorphic. The deposits are associated in some cases with basalt.

LAKE.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
Great Western	Cinnabar, pyrite, bitumen, and quartz	Metamorphic	Metamorphic	Vein.
EAST LAKE.				
Sulphur Banks	(Cinnabar, native sulphur, bitumen, pyrite, borax, alum, and quartz.)	Sandstone and basalt	Sandstone and basalt	Irregular deposit.

LASSEN COUNTY.

This county contains gold-quartz mines. The veins are associated with rocks which are in part metamorphic and probably also in part eruptive, but the specimens in the collection are so decomposed as to be indeterminable. Enormous quantities of lava cover much ground in this part of the state that would probably otherwise be remunerative.

LASSEN.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
HAYDEN HILL.				
Brush Hill	(Gold), quartz	Indeterminable	Indeterminable	Vein.
Golden Eagle	do	do	do	Do.

LOS ANGELES COUNTY.

There is some silver mining in this county. Antimonial silver ores and argentiferous galena occur with pyrite, copper ores, and quartz inclosed between wall rocks which are chiefly sedimentary, but probably in part eruptive. Asphalt, petroleum, and coal, as well as salt, are also found in the county.

LOS ANGELES.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
SILVERADO.				
Blue Light	Galena, pyrite, and quartz	Limestone and quartzite	Limestone and quartzite	Vein.
Dunlap	Galena, zincblende, pyrite, (antimony and copper stains).	Quartzite	Shale.	
Phœnix	do	Probably diorite	Probably diorite.	

MARIPOSA COUNTY.

This is the most southerly county on the gold belt, and contains many gold-quartz veins inclosed in slate. Argentite, proustite, and (it is said) silver telluride are also found. The southern end of the mother lode is in this county on the famous "Mariposa estate".

MARIPOSA.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
MARIPOSA.				
Hill	(Free gold, galena, copper pyrite, occasionally gold; pyrite, zincblende quartz, telluride ore.)	Graphitic slate	Graphitic slate	Vein.
SEBASTAPOL.				
Modesta	Proustite, argentite, and quartz, (telluride ore)			Probably vein.
Coe	(Free gold quartz)		(Slate)	Vein.

NAPA COUNTY.

In this as in the adjoining county, Lake, the principal useful mineral found is cinnabar, which occurs in the usual serpentinoid and arenaceous metamorphic strata. The Redington mine is one of the most important quicksilver producers in the state.

NAPA.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	WALLS.		Character of deposit.
		Foot.	Hanging.	
CAT HILL.				
Napa Consolidated	Cinnabar, with sandstone and clay, (bituminous matter).	Sandstone	Sandstone	Vein.
Redington	Cinnabar, metacinnabarite, marcasite, bitumen, quartz, (mispickel).	Serpentine	Schist	Irregular bodies.

MONO COUNTY.

This county seems to contain two classes of deposits. The highly doré silver, or low-grade gold of Bodie, is found in eruptive rocks of as yet undetermined character. A portion of the gold is free, but a large part of it is associated with complex silver sulphides, accompanied by quartz and calcite as gangue minerals. The other districts are granitic and carry chalcopyrite, copper glance, and carbonates, with galena, zincblende, argentite, and other silver minerals.

MONO.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	WALLS.		Character of deposit.
		Foot.	Hanging.	
BLIND SPRING.				
Comanche	Copper glance, chalcopyrite, zincblende, probably tetrahedrite, chrysocolla, (partzite, malachite, clay, and quartz).	Granite	Granite	Vein.
Diana and Kerrich	Copper glance, chrysocolla, copper carbonates, limonite (partzite and malachite), with earthy and (decomposed granitic gangue).	do	do	Do.
Modoc	Copper glance, chrysocolla, copper carbonates, (galena and horn-silver).			
BODIE.				
Bechtel Consolidated	(Gold and silver bearing quartz)	(Porphyry)	(Porphyry)	Vein.
Bodie Consolidated	do			Do.
Boston Consolidated	(Gold and silver bearing iron-stained quartz)			Do.
Bulwer	(Quartzose and feldspathic vein matter carrying gold and silver.)			Do.
McClinton	(Gold and silver bearing quartz)	(Birdseye porphyry)	(Birdseye porphyry)	Do.
Noonday	do			Do.
Ore	(Pyrargyrite and proustite)	(Porphyry)	(Porphyry)	Do.
Standard Consolidated	(Gold and silver bearing quartz)	do	do	Do.
Defiance	(Gold, silver, quartz, and feldspathic matter)	Indeterminable (volcanic)		Do.
Geodshaw	(Auriferous quartz)	(Porphyry)	(Porphyry)	Do.
Jupiter	(Argentiferous gold quartz)	(Volcanic)	(Volcanic)	Do.
BOMER.				
Maybell	(Gold, silver, iron pyrite, galena, and quartz)	Quartz-porphyry (?)	Quartz-porphyry ?	Vein.
May Lundy	do	Granite	Granite	Do.
INDIAN.				
Illinois	Tetrahedrite, zincblende, and quartz	(Granite and porphyry)	(Granite and porphyry)	Vein.
Tower	Galena, zincblende, native silver, tetrahedrite, (pyrargyrite, pyrite, and quartz).	do	do	Do.

NEVADA COUNTY.

Nevada has always been one of the most productive counties in the state, both the quartz and the placer mines yielding very large amounts. The quartz mines are for the most part in the slates characteristic of the main gold belt, but some of them are in granite, and some of them are on the contact between granite and slate. The gold is accompanied by iron and copper pyrites, mispickel, galena, and zincblende. As elsewhere in the gold belt, the proportion of silver is extremely small, even by weight. Though the larger part of the gold is free, the sulphurets are ordinarily much richer than the quartz taken as a whole, and it usually pays to concentrate them and subject them to the Plattner chloridation process. The placer deposits are in part covered by volcanic rocks, chiefly basalt. The cap over a large area, however, is not so deep as to prevent the gravel from being worked, as it does to a considerable extent in the counties further north, while the amount of volcanic material has been sufficient to protect the gravel from extensive erosion. One of the great Tertiary rivers flowed through this county in a southwesterly direction and gave rise to the large gravel accumulations.

NEVADA.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	WALLS.		Character of deposit.
		Foot.	Hanging.	
GRASS VALLEY.				
Idaho	Free gold, galena, iron and copper pyrites, and sometimes zincblende, quarts.	Magnesian metamorphic rock.	Magnesian metamorphic rock.	Vein.
New York	Gold, pyrite, zincblende, galena, quarts, (copper pyrite).	Slate	Slate	Do.
Rocky Bar	(Gold), pyrite, (zincblende, galena, iron, and copper pyrite), quarts.	Metamorphic	Metamorphic	Do.
NEVADA CITY.				
Merrifield	Pyrite and quarts.			
Murchie	(Gold), pyrite, (galena, copper, and iron pyrite), quarts.	Granite	Granite	Vein.
Providence	(Gold, iron, and copper pyrite, galena, zincblende, and quarts.)	Slate	do	Do.

PLACER COUNTY.

Placer lies directly across the gold belt, and is one of the principal producing counties. The gold-quartz veins occur for most part in slates, though some are found in granite, and they present the usual association of sulphurets. The auriferous gravels have been sufficiently protected by volcanic material to escape radical erosion without being so deeply covered as to be inaccessible. Iron-ore deposits are abundant.

PLACER.

[NOTE.—Determinations in parentheses are given on authority of the experts.]

Mine.	Ore and gangue.	WALLS.		Character of deposit.
		Foot.	Hanging.	
COLFAX.				
Rising Sun	(Gold quarts)	(Granite)	(Granite)	Vein.

PLUMAS COUNTY.

The gold belt in the latitude of Plumas county is not so sharply defined as further south. Deposits of the precious metal, however, are abundant, both as veins and in gravel. The association of sulphurets accompanying the gold is the same as in Nevada county. The wall rocks are either slates and other metamorphic rocks or granite or both. The slates are sometimes so intersected by auriferous quartz as to give the veins a reticulated character. Although the production of the placer mines is considerable, a large part of the gravel is supposed to be inaccessible through the presence of heavy overlying sheets of basalt.

PLUMAS.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	WALLS.		Character of deposit.
		Foot.	Hanging.	
CHEROKEE.				
Plumas Eureka	(Gold), iron and copper pyrites, galena, quarts	Metamorphic diorite *	Metamorphic diorite *	Vein.
GENESEE VALLEY.				
Genesee	(Gold), slate and quartz	Slate	Slate	Reticulated vein.
INDIAN VALLEY.				
Gold Stripe	(Gold generally free from sulphurets), quarts	(Slate)	Quartzite	Vein.
Green Mountain	(Gold, pyrite), quarts	(Decomposed granite)	(Decomposed granite)	Do.
Monitor	Gold, quarts	(Granite)	(Slate)	Do.
Plumas National	(Quartz), pyrite and mispickel	Slate	Slate	Do.
SENECA.				
Savercool	(Gold), pyrite sandstone, and quartz	(Clay slate)	(Clay slate)	Vein.
Sunnyside Gravel	(Auriferous gravels)		Basalt cap	Placer.

* Examined microscopically

SACRAMENTO COUNTY.

The deposits of Sacramento county are mainly gravels, and are confined to its eastern and northern borders, where it adjoins Placer, El Dorado, and Amador. These gravels are in fact the western extremities of the extensive fields occurring in the more eastern counties. A larger product is usually accredited to the county than it actually yields, much bullion being shipped within its borders which is produced elsewhere. This is a consequence of the commercial importance of several towns of the county, among which is the capital of the state.

SAN BERNARDINO COUNTY.

There are veins in granite in this county which carry gold, copper, silver, and lead. There are also copper veins in limestone. Tin ore deposits are found at Temescal, where the ore is of an unusual character, but these are not now worked. Platinum sand is said to occur.

SAN BERNARDINO.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
CLARK.				
Ally	(Argentiferous), stromeyerite	Limestone	Limestone	Vein.
Ivanpah	(Argentiferous), stromeyerite, copper carbonates, (limestone).	Limestone, probably dolomitic.	Limestone, probably dolomitic.	Do.
Lizzie Bullock	(Argentiferous), stromeyerite, copper carbonates, (limestone).	do	do	
DRY LAKE.				
Desert Chief	(Silver ore), limonite, and quartz	(Granite)	(Granite)	Vein.
Oriflamme	Free gold, limonite, and quartz			Probably vein.
SILVER MOUNTAIN.				
——	(Gold), stromeyerite, malachite, lead, and quartz	(Granite)	(Granite)	Vein.
SAN JACINTO.				
——	Cassiterite and quartz.			
——	Granitic or dioritic sand, said to carry platinum.			

SAN DIEGO COUNTY.

There are some gold-quartz veins in San Diego occurring in metamorphic rocks and granite. Salt also forms one of the resources of this county.

SAN DIEGO.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
BANNER.				
Hubbard	Gold, sulphurets, and quartz	Slate	Slate	Vein.
PINECATE.				
Gold State	(Gold, copper and silver in traces), quartz	(Granite and slate)	(Granite and slate)	Do.
CARGO MUCHACHO.				
Madre, Padre, and Cargo Muchacho mines.	(Free gold), quartz	Metamorphic	Metamorphic	Do.

SAN LUIS OBISPO COUNTY.

There are several occurrences of cinnabar in metamorphic rocks, which appear to be similar to the more northern deposits of this ore. Chromic iron is found in considerable quantities.

SAN LUIS OBISPO.

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
SAN LUIS OBISPO.				
Flores Iron	Chromic iron	Augitic porphyry	Augitic porphyry.	
London Iron	do	Metamorphic*	Metamorphic.*	
SAN SIMEON.				
Oceanic	Cinnabar, sulphur	Sandstone	(Shale)	Impregnation.
Polar Star	Cinnabar.			

* Microscopically examined.

SANTA BARBARA COUNTY.

No important deposits, except of bitumens, are found in this county.

SANTA BARBARA.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
SANTA BARBARA.				
Las Pristas	(Cinnabar, chrome iron)		(Serpentine)	Impregnation.

SANTA CLARA COUNTY.

The chief mineral resources of this county are the cinnabar deposits of the New Almaden and Guadalupe mines. They form irregular deposits, in many cases connected by veinlets of ore. The cinnabar is accompanied by pyrite, calcite, magnesite, and bitumen. Dolomitic limestone, shale, and serpentine are the inclosing rocks.

SANTA CLARA.

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
New Almaden	Cinnabar, mercury, bitumen, calcite, magnesite, and pyrite.	Limestone, shale, serpentine, and dolomite.		Vein.
Guadalupe	Cinnabar (and calc-spar), bitumen, magnesite, quarts.	Serpentine	Serpentine	Do.

SHASTA COUNTY.

There are veins in the schists and granites of this county which carry silver ores and gold associated with iron and copper pyrite, galena, and zincblende. A very remarkable occurrence is that of the Mad Ox mine, where native gold is found in calcite. The deposit is reported as a 2½-foot vein. The foot wall is schist and the hanging wall a siliceous limestone. Quartz and pyrite also occur in this vein as gangue minerals. Shasta contains some gold-placer mines.

SHASTA.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
IRON MOUNTAIN.				
Lost Confidence	(Silver and gold.) The silver is probably present as chloride, limonite, copper, pyrite, marcasite (argentite; the pyrite is rich), quarts.	Schist	Schist	Vein.
NEAR IGO.				
Dry Creek, or Hardscrabble	(Gold)	Slate bed-rock		Placer.
PITTSBURGH.				
Potter Mining Co	Copper oxide, sulphide and carbonate, limonite, pyrite, (silver and zincblende).	Slate (porphyry and slate)	Slate (porphyry and slate).	
SOUTH FORK.				
Chicago	Galena, pyrite, quarts, (chalcopyrite, antimony, ruby silver, native silver, gold, and zincblende).	(Granite)	(Granite)	Vein.
WHISKY CREEK.				
Mad Ox	Native gold in calcite, limonite, quarts, pyrite, (sulphurets and talcose schist).	Schist	Siliceous limestone	Do.

SIERRA COUNTY.

Sierra county lies between Nevada and Plumas, and shares the geological character of those counties. Both its placer and quartz mines produce largely, but present no characteristics not shared by those of the adjoining regions.

SISKIYOU COUNTY.

Siskiyou county contains gold-quartz veins occurring in metamorphic rocks and accompanied by pyrite, mispickel, etc. Greenstone is reported as the hanging wall of the Black Bear and the Klamath, but no specimens of this rock have been received, and it is therefore impossible to pronounce with certainty as to its character. The principal product of the county, however, is derived from the placers, many of which are worked as drift mines.

SISKIYOU.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
INDIAN CREEK.				
Bay City	(Auriferous gravel)	Argillaceous limestone bed-rock.		Placer.
Coyote Gulch	do	Metamorphic bed-rock		Do.
Williams Drift	do	do		Do.
M'ADAMS CREEK.				
Carroll Drift	(Auriferous gravel)	Slate bed-rock		Placer.
Duncan Cameron	do	do		Do.
Hardscrabble	do	do		Do.
Hiyou Gulch	do	Shale bed-rock		Do.
Lincoln, Hart, & Henry	do	do		Do.
Oak Grove	do	do		Do.
Siwash	do	do		Do.
ORO FINO.				
John Young	(Auriferous gravel)	Slate bed-rock		Placer.
QUARTZ VALLEY.				
Johnson	Gold, limonite, and quartz	Brecciated metamorphic rock.		Vein.
SCIAD VALLEY.				
Fort Goff Creek	(Auriferous gravel)	Schist bed-rock		Placer.
Thompson Creek	do	do		Do.
YREKA.				
Pellet and Truitt	(Auriferous gravel)	Schist bed-rock		Do.
SOUTH FORK SALMON.				
Black Bear	(Gold, mispickel, and quartz)	(Siliceous slate and quartzite).	(Greenstone)	Vein.
SAWYER'S BAR.				
Klamath	(Gold, pyrite, and quartz)	(Siliceous slate)	(Greenstone)	Do.

STANISLAUS COUNTY.

This county lies to the southwest of Tuolumne and Calaveras. The mining interests are not large, and consist principally of placer deposits in its northeastern portion, near the boundaries of the counties just mentioned. The gravels of Stanislaus form an extension of those of the adjoining counties.

SONOMA COUNTY.

The only ores found are those of quicksilver, the chief mine being the Great Eastern. As usual, the ore is associated with pyrite and bitumen, the accompanying rocks being sandstone, limestone, and a rock so highly metamorphosed as to resemble basalt until seen under the microscope.

SONOMA.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
GUERNEVILLE.				
Great Eastern	Cinnabar, bitumen, (pyrite)	Sandstone and limestone	Metamorphic*	Vein.

* Microscopically examined.

TRINITY COUNTY.

Though gold-quartz veins occur, placers form the principal deposits of the county. The bed-rock in all the cases reported is sedimentary, and is usually slate. The Johnson mine shows beautiful occurrences of radial marcasite.

TRINITY.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
CAÑON CREEK.				
Berger	(Auriferous gravel)	Schist bed-rock		Placer.
DOUGLAS CITY.				
Smith's Flat	(Auriferous gravel)	Slate		Placer.
INDIAN CREEK.				
Johnson	(Auriferous gravel)	Slate		Placer.
RED HILL.				
Mammoth	(Auriferous gravel)	Slate		Placer.
Center Placer	do	Sedimentary		Do.
Chapman	do	Slate		Do.
Lewiston	do	do		Do.
Trinity	do	do		Do.
Weaver Basin	do	Slate		Do.
Wiltshire	do			Do.
CINNABAR.				
Altoona	Cinnabar and quartz	Serpentine.		

TUOLUMNE COUNTY.

Tuolumne county lies across the main gold belt. Though placer deposits occur, the mineral wealth of this county is chiefly in the form of gold-quartz veins, which are found both in the slates and the granite. The minerals accompanying the gold appear to be independent of this difference in the character of the wall-rocks, and present the usual association of quartz with iron and copper pyrites, galena, etc. The mother lode runs entirely across this county.

TUOLUMNE.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
CONFIDENCE.				
Confidence	(Gold, galena, pyrite, and quartz)	(Granite)	(Granite)	Vein.
JAMESTOWN.				
Harris & Heslip	(Gold quartz)	(Slate)	(Slate)	Vein.
SONORA.				
Golden Gate	(Gold, galena, chalcopyrite, pyrite, calcite, and quartz.)	(Slate)	(Slate)	Vein.
SOULSBYVILLE.				
Soulsby	(Gold, galena, pyrite, and quartz)	(Granite)	(Granite)	Vein.

VENTURA COUNTY.

Bitumens yielding oil and sulphur deposits are found in Ventura.

YUBA COUNTY.

Though there are quartz veins in this county, the principal deposits are placers, which, though they were among the first worked in the state, still yield largely. Comparatively little of the gravel is covered by lava.

OTHER COUNTIES.

Alpine, Colusa, Mendocino, Merced, Tehama, and Tulare counties all produce precious metals, though not in large quantities, and very little is known of the details of their occurrence, but there is nothing to lead to the supposition that the character of the deposits differs essentially from that of the quartz veins and placers of the better known regions adjoining them.

GEOLOGICAL SKETCH OF OREGON AND WASHINGTON TERRITORY.

The topography of Oregon and Washington territory bears a general resemblance to that of California. Near the coast are low ranges, separating from the sea a long valley, to the east of which rise important chains. The mean rainfall in the western portions of this region is very great, and much country is covered by dense forests. To the east of the great ranges the climate and physical character of these two political divisions are similar to those of the adjoining territory of Idaho. Both Washington territory and Oregon produce coal in important quantities, but the precious-metal production of the more northern area is very small, while Oregon yields above a million a year in gold.

Extremely little is known of the geology of these areas, which have been examined almost exclusively with reference to their bearing on doubtful points in the geology of regions to the south and southeast. Mr. King, in his *Systematic Geology*, gives the main facts known on the subject; and some information regarding it is to be found in the Pacific railroad reports and in the *American Journal of Science*.

As has been mentioned, the Sierra Nevada mountains were formed during a great post-Jurassic upheaval. The Cascade range, however, is more recent, although from a topographical point of view it might be regarded as a continuation of the great Sierra. The real northern representative of the Sierra is the Blue Mountain range of eastern Oregon, for both are due to the same orographical cause. The coast of the Pacific ocean of the Cretaceous period, therefore, bent eastward to the north of California, and followed the Blue Mountain range northward. The Blue mountains are composed, like the Sierra, of granite and metamorphic strata, and in the latter Mr. King found Triassic fossils. It is probable that nearly or quite all of the metamorphic rocks of Oregon east of the Blue range are Triassic or Jurassic. The Cascade range contains marine upper-Cretaceous beds, (a) but so far as is known none of later date, and it was probably raised above water-level at the close of the Cretaceous. It was certainly uplifted before the Miocene, for during this epoch a fresh-water lake occupied the interval between it and the Blue mountains. West of the Cascade range, and near the coast on the other hand, Cretaceous and Tertiary strata predominate both in Washington territory and in Oregon, and it is probable that the coast ranges of Washington and Oregon, like those of California, were elevated chiefly by a post-Miocene disturbance.

Throughout the Miocene immense volumes of lava reached the surface in Oregon and Washington territory, and the area occupied by it perhaps forms the largest lava field in the world. It spared an irregular belt along the coast and failed to cover the northeastern corner of Washington and part of eastern Oregon, but buried the rest of the country, in part to a great depth.

Besides granite, the principal massive rock of Oregon and Washington is basalt, but andesites also occur in great quantities. The bed-rock of the Wickaiser mine, Ochoco district, Wasco county, Oregon, is shown by a slide in the census collection to be diorite, proving at least that earlier eruptive rocks are not entirely absent. The ore deposits are chiefly veins in granite or metamorphic strata, and do not appear to be associated with volcanic rocks.

Much the most important mining region of Oregon is Baker county, which lies in the southeastern corner of the state and adjoins Idaho. The gold veins of this region are in granite and metamorphic slates in and near the Blue mountains, and may thus be considered as occurring on a continuation of the gold belt of California. They are accompanied by auriferous gravels, which are of much local importance, though of greatly inferior volume to those of California and Idaho. The same arguments which are held to prove the Tertiary age of the gravels of California would probably apply to these also, but detailed information bearing upon the point is not available. Trias-Jura strata are also exposed in the Cascade range at a few points where the overlying material has been removed by erosion, and a little gold quartz and gravel have been discovered in such localities; for example, in Lewis county.

In the northern part of California, as has been mentioned, the gold-bearing rocks have a wide distribution, and are not confined to a comparatively narrow belt, as they are in the middle of the state. Similarly the gold mines of Josephine and Jackson counties, which adjoin California and lie to the west of the Cascades, do not seem to bear a direct relation to the main ranges; but it is noteworthy that this region of scattered deposits in the two states is also that in which the Sierra and the Coast ranges meet, and are so entangled that as yet no one has succeeded in discriminating the two systems. The geological relations of the Skagit mines, in Washington territory, on the upper waters of the Skagit river, are not known further than that the gold is found in the bed of the present streams and that the surrounding country is mainly granitic. Auriferous sands are found on the southern coast of Oregon, as in northern California, and are worked as wind and tide permit.

Coal-beds are frequent in the belt of country west of the Cascade range. Of these the most important are found at Coos bay, in Oregon, and at Bellingham bay, in Washington territory. The age of the Bellingham bay seams is known to be the same as that of the Monte Diablo coal or Upper Cretaceous, and those of Coos bay are probably also of this period. Iron ore is abundant, and has been smelted to a small extent, but under the disadvantage of high rates for labor. Quicksilver is found at the New Idrian cinnabar mine, Douglas county. Its occurrence seems to be similar to that of the California mines, and it represents the northern end of the series of deposits, the southern extremity of which is in San Luis Obispo county, California. It would be incorrect, however, to characterize this entire series as a "belt", for toward the north the known occurrences are at long intervals.

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a These are of the Tejon group, and may prove to be Eocene.

Whatcom and Yakima counties are the only ones in Washington territory from which gold mines are reported, though small quantities of gold are also obtained from the sands of the Columbia river, while King and Thurston counties produce coal. Oregon, Baker, Grant, Wasco, Douglas, Josephine, Jackson, and Umatilla counties are reported as containing gold mines. Coos yields auriferous beach sands and coal, Clackamas iron, and Douglas cinnabar.

OREGON.

BAKER COUNTY.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
BURNT RIVER.				
Gold Ridge	Quartz, gold, and pyrite	Granite	Granite	Vein.
CONNER CREEK.				
Conner Creek	Quartz, limonite, (gold and sulphurets)	Slate, basalt dike*	Slate, basalt dike*	Do.
FARRIS GULCH.				
Farris Gulch	(Auriferous gravel)	Granite		Placer.
POCAHONTAS.				
Bailey	(Auriferous gravel)	Granite		Do.
Low. Cooper & Co	....do	Argillaceous sandstone		Do.
Salmon Creek	....do	Granite		Do.
Tom Payne	Quartz, gold, (and iron and copper pyrite)	Slate	Slate	Vein.
RYE VALLEY.				
Powers & Co	(Auriferous gravel)	Sandstone		Placer.
Rye Valley	Quartz, stromeyerite, copper carbonates, (antimonide of silver and iron pyrite).	Granite	Granite	Vein.
SHASTA.				
Manadus	(Auriferous gravel)	Gneiss		Placer.
SILVER CREEK.				
California	Quartz, mispickel, pyrite, (stephanite, gold and silver bearing pyrite).	(Unknown)	Granite	Vein.
WILLOW CREEK.				
Boswell	(Auriferous gravel)	Slate		Placer.
Virtue	Quartz, gold, (iron and copper pyrite)	Shale	Shale	Vein.

* Examined microscopically.

COOS COUNTY.

Pioneer Black Sand	Magnetite, titanic iron, quartz, and gold.			

DOUGLAS COUNTY.

New Idrian	Cinnabar, limonite, (feldspar, manganese oxide)		Sandstone	Vein.

GRANT COUNTY.

ELK CREEK.				
Deep Creek	(Auriferous gravel)	Slate		Placer.
Elk Creek	....do			Do.
GRANITE.				
Buffalo	Galena, pyrite, quartz, (stephanite and mispickel)	Quartzite	Slate	Vein.
Barne & Lucas	(Auriferous gravel)	Shale		Placer.
Klopp & Johnson	....do	....do		Do.
Monumental	Tetrahedrite, polybasite, chalcopyrite, pyrite, quartz, (mispickel and zincblende).	Granite	Granite	Vein.
Trail creek	(Auriferous gravel)	Granite		Placer.

JACKSON COUNTY.

APPLEGATE.				
Chapel & Co	(Auriferous gravel)	Slate		Placer.
Grand Applegate	....do	....do		Do.
UNIONTOWN.				
Gin Lin	(Auriferous gravel)	Slate		Placer.
STERLING.				
Sterling	(Auriferous gravel)	Slate		Placer.

JOSEPHINE COUNTY.

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
GRAVE CREEK.				
Steam Beer	(Auriferous gravel)	Slate		Placer.
YANK.				
Sugar Pine	Galena, pyrite, chalcopyrite, and quartz.			

WASCO COUNTY.

OCHOCO.				
Wicknisser & Co.	(Auriferous gravel)	Diorite*		Placer.

* Examined microscopically.

WASHINGTON.

YAKIMA.

[NOTE.—Determinations in parentheses are given on the authority of the expert.]

PRESHAFTON.				
Sheaffer	Quartz, (gold), and pyrite	Metamorphic	Metamorphic	Vein.
SWANK.				
Swank	(Auriferous gravel)	Sandstone (and slate)		Placer.

GEOLOGICAL SKETCH OF NEVADA.

That portion of the wide area included between the Sierra Nevada and the Wahsatch range, the drainage of which does not find its way to the sea, was called the Great Basin by Frémont. The name has passed into general use, but with a somewhat extended signification, and, as commonly employed, includes to the south the desert region lying between the southern California ranges and the Colorado plateau, and to the north so much of Oregon as lies east of the Blue Mountain range and a somewhat indefinite portion of Idaho. The state of Nevada, with the western half of Utah, constitutes the larger and more important part of the Great Basin.

Leaving the mountains out of consideration, the basin may be considered as a high plain with an average elevation of perhaps 4,500 feet; but the central portion is higher than the edges, the belt of country next west of the Wahsatch and that next east of the Sierra being about 4,000 feet above sea-level, while near the middle of Nevada the elevation is about 6,000 feet above tide-water.

The Great Basin is strikingly characterized by rather short mountain ranges with nearly meridional trend, separated by valleys a few miles wide. The culminating peaks rise from 2,000 to 6,000 feet above the level of the surrounding country, and the ranges often present an imposing appearance, though they are greatly inferior to the Sierra and the Wahsatch as topographical features. Many of the valleys are totally devoid of vegetation, and present a surface of alkaline salts (mostly sodium chloride, carbonate, or sulphate), but the greater portion of the country is thinly clothed with "sage brush", low-growing shrubs with dull gray-green foliage, the most abundant of which is *Artemisia tridentata;* on the higher portion of the mountains, where a certain amount of moisture is supplied by the slow melting of the scanty snowfall, nut-pines, junipers, and mountain mahogany grow to a limited extent. The few streams are also fringed with narrow belts of vegetation.

The principal rivers of Nevada are the Humboldt, the Carson, the Truckee, and the Quinn. All of these streams dwindle after reaching comparatively level ground by evaporation and absorption, and at last empty into small salt lakes which have no outlets. The alkali deserts unquestionably mark the positions of similar lakes now completely dried away.

Though there are many contributions to the geology of Nevada, no complete survey of it has ever been made. The exploration of the fortieth parallel, however, covered a belt of 100 miles in width and extended across the state from east to west, beside taking in some outlying districts of importance; and most of the statements as to the general geology of Nevada in this account are derived from the publications of that survey.

The Archæan is exposed at a large number of points along the crests of the mountain ranges of Nevada, and these, taken in connection with the overlying strata, show that prior to the Palæozoic era a mountain system covered the area of Nevada and extended to the east as far as the 104th meridian. This system, however, seems to have been entirely suboceanic, for the ranges were extremely lofty, yet they presented broader and smoother surfaces than subaerial erosion is ever known to produce.

During the Palæozoic a continent occupied western Nevada and most of California, its eastern shore intersecting the 40th parallel in longitude 117° 30′ (a few miles west of Austin) and trending nearly north and south. The sediments from this western continent, as well as from comparatively unimportant islands, accumulated throughout

the Palæozoic era on the sea-bottom, which subsided as the load increased, until the strata reached the enormous thickness of 40,000 feet near the shore, thinning out to the eastward. The Palæozoic was an era of extreme quiet, so that the geologists of the fortieth parallel were able to detect no unconformity in its strata. During the Carboniferous period the Palæozoic sea was for the most part so deep that the sediments were almost exclusively limestones, in which it is hopeless to look for coal. Near the shore, however, land plants, associated with carbonaceous beds, occur in a single horizon, but even this is underlaid and overlaid by calcareous deposits and is of limited extent. At the close of the Palæozoic era the land and the sea changed places. The sea-bottom, from longitude 117° 30′ to and including the Wahsatch, rose above the surface of the water, while the continent which had stretched to the west sank and formed an ocean floor, upon which the sediments from the new continental area were deposited. The Triassic and Jurassic periods were also extremely quiet, and the strata are conformable throughout.

At the close of the Jurassic age the western ocean, with its original floor of Archæan ranges overlaid by twenty odd thousand feet of conformable Trias-Jura sediments, suffered abrupt orographical uplift, resulting in the formation of a series of sharp folds and elevating a portion of the ocean area, extending from the eastern shore outward and westward as far as the present west base of the Sierra Nevada, making an addition to the continent of 200 miles, the Sierra itself constituting the most western and most elevated of the newly-formed mountain ranges. The character of the orography of this period of disturbance is that of tangential compression, in which the gentler action was close to the old shore in the meridian of 117° and most powerful in the crumpled western slope of the Sierra Nevada, where the Triassic and Jurassic series have their enormous thickness crushed into a mass of almost indistinguishable folds, the rocks thrown into vertical dip and crowded together, making a belt of strata about fifty miles broad. This orographical action continued southward as far as the defined range of the Sierra Nevada extends and northward along the whole shore of the Pacific, probably as far as the Alaskan peninsula. Passing northward from the region of the fortieth parallel, where the new addition to the continent measured about 200 miles from east to west, the zone of crumpled Mesozoic was depressed so that the new ocean shore at the beginning of the Cretaceous age touched the west base of the Jurassic fold of the Blue mountains of eastern Oregon. (*a*)

It is not certain that the whole system of Basin ranges dates from the post-Jurassic disturbance, for the corrugation of the Palæozoic area east of 117° might have accompanied its uplift immediately after the Carboniferous. There are considerable grounds, however, for supposing that uplift to have been comparatively quiet, and it is on the whole probable that all the ranges were raised by the same movement which crumpled the Trias-Jura strata of the Sierra.

The views of the various geologists who have studied the basin ranges are not uniform as to the character of the dynamical action which resulted in the upheaval of these mountains. The geologists of the fortieth parallel regard the ranges as composed of synclinal and anticlinal folds more or less obscured by longitudinal compression and by faulting long subsequent to their upheaval. Pfaff (*b*) and others hold that faults are the extreme results of forces tending to form folds in an imperfectly elastic material, and that folds consequently frequently pass over into faults; and as long ago as 1870 Mr. Emmons (*c*) pointed out a case of this kind in the Toyabe range. Messrs. Powell and Gilbert, on the other hand, from investigations made mainly to the south of the fortieth parallel belt, maintain that many of the uplifts are purely monoclinal in character.

The Cretaceous is wholly wanting in the state of Nevada as well as in the great Sierra. This area was certainly above sea-level during that epoch, and if any fresh-water deposits formed they were swept away before Tertiary strata covered and protected them. Professor Whitney considers the absence of Cretaceous fossils in the Sierra as so remarkable that he infers the possibility that this area was unsuited to animal and vegetable life. (*d*)

The Tertiary and the Quaternary eras in Nevada were characterized by the presence of lakes, which occupied different localities as orographical disturbances altered the drainage system. The present period of desiccation, during which evaporation has so increased and precipitation so diminished that the lakes no longer overflow and the salts brought into them by the streams are retained in nearly saturated solution, has not been a long one from a geological standpoint; and, according to Professor Whitney, it is shorter than that during which man has been an inhabitant of the Pacific coast. Mr. King presents evidence to show that there has been more than one period of desiccation in the Quaternary.

The massive rocks of the Great Basin are very numerous, and are referable to three distinct eras of eruptive activity. The granites are found only associated with Archæan rocks, and never penetrate overlying strata. Important eruptions of diorite and diabase accompanied the post-Jurassic upheaval; while in the Tertiary and Quaternary andesites, rhyolites, and basalts were ejected in great quantities, usually reaching the surface along lines of disturbance established in the Mesozoic era. The crests of a large portion of the Nevada ranges are still covered by these lavas, among which rhyolite predominates. Propylite, which had been supposed to exist at a number of points in the Great Basin, does not appear to be an independent rock, but to represent a certain stage of decomposition. (*e*)

Recent advances in the microscopical study of rocks tend to show that sanidin feldspar is of much rare occurrence than has hitherto been supposed. A recent revision (*f*) of the fortieth parallel collection by Messrs.

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a *Exploration of the Fortieth Parallel*, vol. i, p. 537.
b *Mechanismus der Gebirgsbilding.*
c *Exploration of the Fortieth Parallel*, vol. iii, 326.
d *Auriferous Gravels*, p. 319.
e *Monographs United States Geological Survey*, vol. iii.
f *Third Annual Report of the United States Geological Survey.*

Hague and Iddings, to the results of which the writer has had access in advance of their publication, shows that there are probably no true trachytes among the rocks hitherto collected from the Great Basin.

Ore deposits occur at a great number of points in Nevada, carrying gold, silver, lead, copper, and other useful minerals. They are not limited to rocks of any age. The Archæan granite of Austin, the Palæozoic strata of Eureka and White Pine, and the Mesozoic rocks of Washoe are sufficient examples of this fact. The deposits occur in the mountains, as is usual the world over, and as the Nevada mountains are disposed in parallel ranges, of course the mines also occur in parallel belts. There is a perceptible tendency to the development of the same minerals at different points on the same belt, though there are no ore-bearing zones comparable in continuity with the gold and the quicksilver belts of California. The possibility that the deposits of Battle mountain, Austin, Candalaria, etc., form a continuation of the Arizona belt has already been adverted to.

In most cases it is impossible to determine the age of the deposits, yet there are many phenomena indicating a connection between them and eruptive activity, and they are probably for the most part referable either to the post-Jurassic period of upheaval or to that of the more recent volcanic eruptions. The gold veins of California, as has been explained, are post-Jurassic; and the Idaho gold veins are probably, at least in part, of the same age. It is difficult to suppose that the similar physical conditions prevailing in Nevada during the same period were not attended by similar mineralogical results. The Comstock, however, is probably very recent and a concomitant of volcanic eruptions in its immediate neighborhood. Mr. King drew attention (*a*) to the fact that no ore pebbles have been found in the Tertiary lake beds of Nevada, and this statement still remains valid so far as the exploration of the fortieth parallel is concerned. Nor are prospectors known to have found any indications of ore in these beds. This negative evidence is all in favor of the supposition that the deposits are mainly Tertiary and post-Tertiary.

THE COMSTOCK LODE.—The Comstock lode is situated in Storey county, about 10 miles from the eastern limit of the Sierra, and lies on the east flank of the Virginia range. In twenty-one years it has produced a little over $306,000,000 worth of bullion, of which $132,000,000 was gold. The mines on this lode are the deepest in America, reaching a distance of over 3,000 feet from the surface, and containing 185 miles of galleries. The lode is extremely wide in places, and has been traced horizontally for about 4 miles. It dips east at an angle of about 45°.

The Washoe district is almost entirely made up of eruptive rocks of post-Jurassic and Tertiary age. These are in large part highly decomposed, and both their character and the structural relations of the vein have given rise to much difference of opinion between observers. According to the latest investigation, (*b*) the most productive portion of the lode is associated with a hanging wall of diabase, while the foot wall in Virginia City is diorite, and in Gold Hill metamorphic slate. To the north and south of the most productive portion of the lode, which has hitherto been between the Union and Overman mines, the vein ramifies, only its northeastern branch remaining in contact with the diabase.

A great fault attended the opening and filling of the vein. Its throw was nearly 3,000 feet at the middle of the lode, diminishing in each direction toward the extremities. The faulting action resulted in the formation of a system of fissures, which divides the country rock on each side into a series of parallel sheets. By this means the east wall, which was depressed by the fault, assumed near the surface the shape of a sharp wedge, and the projecting edge was broken through, giving rise to a secondary fissure, forming an angle of 30° to 45° with the lode plane. The lode was charged with ore and quartz by lateral infiltration from the east or hanging side, these materials being deposited wherever there was an open space or a space filled with loose fragments to receive them. Of such spaces the secondary fissure, or "east vein", as it has been called, afforded a large number, while below the junction of this fissure with the main lode such openings were comparatively infrequent. The fault mentioned did not take place all at once, and probably consisted of a great number of small movements, all in the same direction, extending over the whole period of ore deposition. Although small, these movements took place with irresistible force, and crushed such ore bodies as crossed the lines of motion to such an extent that their substance resembles ordinary commercial salt in texture and appearance.

As is usually the case in silver veins, the distribution of ore in the quartz was by no means regular; a fact probably depending on the irregularity of the leaching process. While very little of the quartz is free from traces of precious metals, only certain spots contain enough to pay the expense of extraction, and are hence known as "bonanzas". (*c*) These, however, commonly occur in the largest quartz masses.

Though the Comstock is not just now in a flourishing condition, there seems to be no reason why large ore bodies should not yet be met with. The first condition for an ore body is a space to receive it. The existence of such openings depends upon mechanical conditions which are likely to be repeated at almost any depth, though a series of bonanzas on one level, such as was found in the "east vein", is not likely to recur.

It is highly probable that the depth to which the Comstock can be explored will be limited by the extraordinary heat. The Gold Hill mines have been flooded with water of a temperature of 170° F., and as the temperature of the rock and the water increases on the whole in direct proportion to the depth boiling water may be met at

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a *Exploration of the Fortieth Parallel*, vol. iii, p. 7.
b *Monographs United States Geological Survey*, vol. iii.
c A Spanish term, the nearest equivalent of which is "pay rock".

almost any time after the 4,000-foot level is reached. The heat of the water and the rock is a remnant of volcanic action.

AUSTIN.—The property of the Manhattan Mining and Milling Company is situated at Austin, Lander county. (*a*) It is famous for its steady yield of above $1,000,000 of silver a year from very rich but also very rebellious ores. The Toyabe range, on which Austin lies, is near the western edge of the Palæozoic area which occupies the eastern half of the Great Basin. It has a granitic axis flanked by Palæozoic strata, and is capped to a considerable extent by rhyolite. Other eruptive rocks occur in the range, which must be for the present regarded as of uncertain character. The most important mineral deposits are found as veins in the granite, chiefly on the southern slope of Lander hill.

The outcrops on the hillside are very numerous, and many locations have been made; some within 10 or 20 feet of each other. Some of these outcrops have been proved by actual development to be well-defined and persistent fissures; others are probably mere seams or branches that pinch out or unite with stronger veins in depth; and that many must disappear in this manner seems apparent, from the fact that the number of veins or fissures cut in the deeper cross-cuts and shafts in various parts of the hill bear a very small proportion to the number of outcrops at the surface in their immediate vicinity, which, if persistent, would appear below.

The developments on Lander hill show that within this mineral belt, running north and south, there prevails a zone more favored than the rest, within the limits of which the northwest and southeast veins traversing it are especially rich in ores of high value, and beyond which the proportion of base metals is greatly increased. This zone, so far as understood, also has a north and south direction. On Lander hill it may be from a quarter to a half mile in width. Its western limit is thought to pass through the Diana and the Savage mines, so that in passing from the southeastern to the northwestern portions of those claims a perceptible diminution of the richer and purer silver-bearing minerals, and an increasing predominance of baser metals, such as lead, copper, zinc, antimony, and iron, take place. Proceeding still further west, the proportion of rich silver minerals to the baser compounds becomes still less, until the ore is quite too poor to pay for extraction. (*b*)

The veins are comparatively very narrow, none, so far as reported, exceeding 3 feet. Many of them, however, are so rich that they can be worked with profit when showing only 3 inches of ore. The ore minerals are pyrargyrite, proustite, stephanite, polybasite, tetrahedrite, argentiferous galena, zincblende, and iron and copper pyrites. The amount of gold is said to be so small as not to pay for separation. The gangue minerals are chiefly quartz, manganese-spar, and calcite. Near the surface the veins carried the silver as chloride, but at a depth of 150 feet this facile ore was replaced by the rebellious compounds above mentioned. There can be little doubt that the chloride was formed by the decomposition of the more complex minerals.

The granite at a distance from the veins is extremely hard and tough, but near the ore it is much softer and shows signs of decomposition. A slide of this rock in the census collection shows that it is a normal biotite granite which has been subjected to the action commonly known as solfataric. The mica has been in part converted into chlorite, and in this latter mineral bunches of epidote crystals have developed, evidently at the expense of the chlorite, while the feldspar is scarcely affected. This fact, taken in connection with the relations of the altered rocks and the whole character of the occurrence, leads to the supposition that the veins were deposited by lateral secretion. All the veins are faulted to the north for a distance of about 200 feet, and Mr. Emmons considers it not improbable that this dislocation accompanied the eruption of the rhyolite which forms mount Prometheus.

The age of formation of the veins is uncertain. The fact that faults have taken place since the ore was deposited is at least compatible with the supposition that the deposits are post-Jurassic; but were this the case, eruptive rocks of the same age would probably be formed in the neighborhood, while none such have been recognized. The formation of the veins is naturally connected with the metaphorism of the sedimentary rocks of the range, which seems to be due to later volcanic eruptions. The fact that the number of croppings occurring at the surface was larger than that of the veins found at a comparatively slight depth would also lead one to suppose that this multiplicity of outcrops was a surface phenomenon, and that no great erosion had taken place since the ore was deposited. It is not impossible that the lines of fracture were established in post-Jurassic times, and that the filling of the veins and their dislocation occurred much later.

The mines of the Manhattan Company cover a large extent of ground, more than a square mile, but the greatest depth reached is only 900 feet. The small size of the veins makes mining extremely expensive however, a very large amount of waste being necessarily extracted in stoping the veins. The richness of the ore is indicated by the fact that it is mixed for roasting so as to give a tenor of $250. The milling process consists in crushing dry, roasting with salt in a Stetefeldt furnace, and amalgamation in pans.

EUREKA DISTRICT.—The value of the ore deposits of Eureka was not determined until the year 1870, since which time, however, this has been one of the most important lead- and silver-producing districts of the country. It now produces about $4,600,000 of gold and silver, and nearly or quite 12,000 tons of lead annually.

It is remarkable geologically as affording a very extensive section of Palæozoic strata. It has recently formed the subject of a detailed investigation by Mr. Arnold Hague, whose monograph on the *Geology of the Eureka District* will appear about the same time as this volume. He has kindly given permission to print the accompanying section, showing the average thickness and the succession of the rocks, and indicating by a double line a non-conformity in the Silurian, the first thus far discovered in the Palæozoic of the Great Basin.

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a Mr. S. F. Emmons has reported on the geology of the Toyabe range, and Mr. J. D. Hague on the mining and milling at Reese river. *Exploration of the Fortieth Parallel*, vol. iii.

b *Exploration of the Fortieth Parallel*, vol. iii, p. 351.

GEOLOGICAL SECTION OF THE EUREKA DISTRICT.

By Mr. Arnold Hague.

Carboniferous, 9,500 feet.	Upper coal measures	500	Light-colored blue and drab limestones.
	Weber conglomerate	2,000	Coarse and fine conglomerates, with angular fragments of chert; layers of reddish-yellow sandstone.
	Lower coal measures	3,800	Heavy bedded dark-blue and gray limestone, with intercalated bands of chert; argillaceous beds near the base.
	Diamond Peak quartzite	3,000	Massive gray and brown quartzite, with brown and green shales at the summit.
Devonian, 8,000 feet.	White-pine shale	2,000	Black argillaceous shales, more or less arenaceous, with intercalations of red and reddish-brown friable sandstone, changing rapidly with the locality. Plant impressions.
	Nevada limestone	6,000	Lower horizons indistinctly bedded, saccharoidal texture, gray color, passing up into strata, distinctly bedded, brown, reddish-brown, and gray in color, frequently finely striped, producing a variegated appearance. The upper horizons are massive, well bedded, and bluish-black in color. Highly fossiliferous.
Silurian, 5,000 feet.	Lone Mountain limestone	1,800	Black gritty beds at the base, passing into a light-gray siliceous rock, with all traces of bedding obliterated. Trenton fossils at the base. Halloysites in the upper portion.
	Eureka quartzite	500	Compact, vitreous quartzite, white, bluish, passing into reddish tints near the base; indistinct bedding.
	Pogonip limestone	2,700	Interstratified limestone argillites and arenaceous beds at the base, passing into purer, fine-grained limestone of a bluish-gray color, distinctly bedded. Highly fossiliferous.
Cambrian, 7,700 feet.	Hamburg shale	350	Yellow argillaceous shale layers of chert nodules throughout the bed, but more abundant near the top.
	Hamburg limestone	1,300	Dark-gray and granular limestone. Surface weathering rough and ragged; only slight traces of bedding.
	Secret Cañon shale (overlies the ore-bearing rock).	1,000	Yellow and gray argillaceous shales, passing into shaly limestone. Near the top interstratified layers of shale and thinly-bedded limestone.
	Prospect Mountain limestone (incloses the ore deposits).	3,050	Gray compact limestone, lighter in color than the Hamburg limestone, traversed with thin seams of calcite. Bedding-planes very imperfect.
	Prospect Mountain quartzite (underlies the ore-bearing rock).	1,500	Bedded brownish-white quartzites, weathering dark-brown; ferruginous near the base. Intercalated thin layers of arenaceous shales. Beds whiter near the summit.

It appears from this table that the ore deposits lie in the lower horizons of the Cambrian. When they were formed is quite another question. The district shows a number of massive rocks, viz: Archæan granite and Tertiary or post-Tertiary andesites, dacite, rhyolite, and basalt. The eruptions most closely associated with the mines were rhyolite, and a connection between this rock and the ore may fairly be suspected; but the deposits are still under investigation, and something more satisfactory regarding their nature and genesis than any speculation which could be offered here will probably soon be ready for publication.

The ores of Ruby Hill are argentiferous galena, accompanied by its decomposition products. Indeed, the larger part of the ore thus far mined is carbonate, mixed with some sulphate and ocher, as well as with mimetite and wulfenite, the occurrence of which indicates the presence of considerable quantities of other metalliferous mineral besides galena prior to decomposition. The ore bodies are irregular, kidney-shaped masses distributed in limestone. This rock, though highly metamorphosed, is distinctly stratified in parts, and has been proved by Mr. Hague's party to carry fossils which determine its age as Cambrian. The nature of these ore deposits has formed the subject of repeated lawsuits, and the many well-known geologists and mining engineers who have given testimony on the subject have expressed very discordant views, some holding them to be pipe veins in the limestone, while others regard the whole limestone formation between the quartzite and the shale as ore-bearing, the barren portions answering to the bone in coal seams. While the one party consider the small seams of ore sometimes found connecting the ore bodies as the rake vein corresponding to the pipes, the other party attributes these seams to the accidental presence of fissures, and ascribes no significance to them. The diversity of opinion developed as regards the de; osits of Ruby Hill appears to indicate merely that large financial interests are involved in the title to this property, and not that there is anything exceptional in the character of the deposits themselves. Lead ores are more often found in limestone than elsewhere, and when so found almost always exhibit great irregularity in form and distribution. The fact is that little is definitely known with reference to the *modus operandi* of the deposition of galena. As Mr. Emmons, (*a*) in discussing the deposits of Leadville, has pointed out, if the hypothesis

(*a*) *Second Annual Report of Director of United States Geological Survey.*

often advanced that this ore has been deposited in pre-existing caves were correct concentric structure would necessarily result. He regards it as more probable that the ore has been deposited by substitution for limestone. If this can be shown conclusively, lead deposits of this character would have to be regarded as veins differing from the usual type merely in the extreme irregularity of the walls; for an ordinary vein is merely an opening in the rocks, which is always limited in horizontal extent, and probably also in depth. Into such a fissure metalliferous solutions percolate and deposit ore minerals, precipitation being due to chemical or physical causes. Usually the walls of veins are chemically inert, and hence do not lose their original form; but if the substance of the walls of a vein, instead of, *e. g.*, infiltrations of organic matter, were to induce precipitation, that fact certainly would not deprive the resulting deposit of its character as a vein, though the shape of the walls might be strangely modified.

A very remarkable feature of the Eureka deposits, shared to a greater or less degree by many others in the Great Basin, is the great depth to which decomposition, involving an accession of oxygen, has proceeded. The mines are between 1,200 and 1,300 feet deep; yet, although some water has been met of late, the permanent water-level has not been reached, and the amount of galena in the ore is scarcely more than enough to prove that the original lead mineral was the sulphide. The conversion of the galena to carbonate and sulphate, which must clearly be ascribed to the agency of atmospheric oxygen, could take place to such a depth only in an extremely dry country such as the Great Basin now is, and the decomposition must therefore have been accomplished since the early Quaternary.

CHURCHILL COUNTY.

The product of this county has for the most part been confined to borax, but there are quartz veins in the IXL district occurring in granite and on the contact between granite and limestone. They carry silver and galena, but were not worked during the census year.

ELKO COUNTY.

The deposits of the Tuscarora district, in this county, are silver ores, including light and dark ruby silver, stephanite, argentite, and, near the surface, horn-silver. They are accompanied by pyrite, often argentiferous, and form veins in highly decomposed eruptive rock. This was formerly considered to be propylite, but from the slides and specimens of the census collection and of the fortieth parallel collection, and from known occurrences in the neighborhood, it is probable that the rock should be regarded as an altered hornblende-andesite.

ELKO.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls		Character of deposit.
		Foot.	Hanging.	
TUSCARORA.				
Belle Isle	Stephanite; gangue quartz, pyrite, and chalcopyrite	Probably andesite*	Probably andesite*	Vein.
Argenta	Horn-silver, dark and light ruby silver, and probably stephanite; gangue country rock.	....do	....do	Do.
Grand Prize	Light and dark ruby silver, argentite, horn-silver near surface; gangue quartz, iron and copper pyrite, and zincblende.	....do	....do	Do.
Independence	Horn-silver, (sulphides on lower levels), (quartz)	....do	....do	Do.
Navajo	Chloride; gangue, (quartz and spar)	Andesite*	Andesite*	Do.
North Belle Isle	(Chloride, ruby, and argentiferous pyrite; gangue, spar, and quartz.)	(Birdseye porphyry)	(Birdseye porphyry)	Do.
Silver Star	(Antimonial ruby and argentiferous pyrite; gangue, spar, and quartz.)	(Porphyry)	(Porphyry)	Do.

* Microscopically examined.

ESMERALDA COUNTY.

Most of the mines of this county exploit deposits in the metamorphic slates and schists. These are broken through at numerous points by volcanic rocks, especially basalt, to which the solfataric action attending the formation of the ores is possibly due. The ores resemble some of those found in Inyo county, California, carrying sulphantimonides of silver, argentiferous galena, tetrahedrite, copper and iron pyrite, zincblende, and pyrolusite, in a quartz gangue. There are also gold-quartz veins in granite, similar to those of California. In the Columbus district there is a nickel vein.

The Northern Belle mine is sunk on a series of irregular deposits, forming a belt which is, in general, conformable to the slates in which it lies. There is much basalt in the immediate neighborhood. Most of the ore is oxidized, but a few bunches of sulphurets are left, carrying galena, tetrahedrite, etc. The Northern Belle produces about a million a year.

ESMERALDA.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
COLUMBUS.				
Mount Potosi	Gold and calcareous ocher, (lead, said to carry silver and gold); gangue quartz; (antimonial compounds).	Slate	(Porphyry)	Vein.
Nickel	Nickel in an indeterminable form.			
Monte Diablo	(Same as Northern Belle.)			
Northern Belle	Horn-silver, malachite, galena, and tetrahedrite; gangue, iron oxide, pyrolusite, pyrite, quartz, (zincblende).	Slate (called porphyry)	Slate	Do.
Victor	(Horn-silver, malachite, galena, and antimonial silver); gangue quartz, and iron oxide.		(Slate)	Do.
ESMERALDA.				
Real del Monte	Gold, (copper); gangue quartz and iron oxide			Vein.
OREOTA.				
Indian Queen	Galena and chalcopyrite, (small quantities of sulph-antimonides of silver); gangue, pyrite, quartz, and zincblende.	Mica-schist	Mica-schist	Vein.
WILSON.				
Wilson	(Gold); gangue quartz, iron and copper pyrites	Granite	Rhyolite and limestone	Mineral belt.
Wheeler	do	do	do	Do.

EUREKA COUNTY.

The chief deposits of this county, those of Ruby Hill, have been sufficiently enlarged upon. Most of the others are also of lead ores, and occur either in or close to limestone, but some of them, those for instance of Cortez district, are accompanied by copper minerals, native silver and mispickel, and some have more or less quartz as gangue. These are of especial value in smelting the prevailing extremely basic ores.

EUREKA.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
CORTEZ.				
Garrison	Chloride, galena, tetrahedrite, native silver, and malachite; gangue, zincblende, and mispickel, (quartz).	(Limestone)	(Limestone)	Irregular deposit.
EUREKA.				
Alexandria	Cerussite, (gold and silver, gangue quartz and iron oxide.)	(Limestone)	(Limestone).	
Eldorado No. 2	(Carbonate, silver and gold, gangue quartz and iron oxide.)	Limestone	Limestone.	
Eureka Consolidated Jackson Richmond Phœnix	Argentiferous galena, cerussite, anglesite, mimetite, wulfenite, with limonite and aragonite gangue.	do	do	Irregular bodies or pipe veins.
Macon City	(Cerussite containing gold and silver, gangue quartz, and iron oxide.)	do	do	Irregular mass.
Silver Lick	Cerussite, gangue quartz and iron pyrite		Shale.	
SECRET CAÑON.				
Geddes & Bertrand	Argentiferous cerussite, gangue quartz and iron oxide.	Limestone	Limestone	Irregular mass.
EUREKA.				
Silver Corner	Galena and alteration products (telluride)	Limestone	Limestone.	

HUMBOLDT COUNTY.

Most of the veins are in the Mesozoic slates, and carry ruby silver and stephanite with iron and copper pyrite and mispickel in a quartz gangue. Near the croppings the silver takes the form of chloride. Some of the veins in the slates are worked for gold, but of these a part will probably be found to carry more silver than gold when the water-level is passed. The Pride of the Mountain, Winnemucca district, is reported to be on a contact between slate and granite.

HUMBOLDT.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	WALLS.		Character of deposit.
		Foot.	Hanging.	
MOUNT ROSE, OR PARADISE.				
Big Nick	Chloride, gangue quartz.	Slate	Slate	Vein.
Bullion of Paradise	Chloride, pyargyrite, (ruby and stephanite); gangue quartz, pyrite, mispickel, chalcopyrite, and iron oxide.	do	do	Do.
Live Yankee	Same as Big Nick	do	do	Do.
Uranus	do	do	do	Do.
SIERRA, OR DUN GLEN.				
Lang Syne	Gold with quartz gangue	Silicified sedimentary rock (called porphyry).	Silicified sedimentary rock (called porphyry).	
Lucky Boy	Copper-stained quartz, (gold)	(Slate)	(Slate)	Vein.
WINNEMUCCA.				
Pride of the Mountain	(Sulphurets and antimonial silver minerals, with quartz gangue.)	(Slate)	(Granite)	Contact vein.

LANDER COUNTY.

Besides the Austin mines, sufficiently described above, there are veins of ruby silver, etc., in quartzite, and of galena with quartz gangue in Palæozoic slate.

LANDER.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	WALLS.		Character of deposit.
		Foot.	Hanging.	
BATTLE MOUNTAIN.				
Reina	Galena, gangue pyrite and (quartz)	Slate	Slate	Vein.
LEWIS.				
Starr & Grove	Ruby and sulphurets with (quartz gangue)	Quartzite	Quartzite	Vein.
REESE RIVER.				
Manhattan or Curtis	Dark and light ruby silver, stephanite, polybasite, tetrahedrite, galena, iron and copper pyrites, and quartz.	Granite*	Granite*	Vein.

* Microscopically examined.

LINCOLN COUNTY.

This county shows several classes of deposits. There is a considerable number of occurrences of galena and its decomposition products in limestone similar to those of Eureka and elsewhere, and which seem especially abundant in the Palæozoic limestone of the Great Basin. The Meadow Valley and Raymond & Ely are also in metamorphic strata; but these are quartzites, not limestones, and the character of the ore is correspondingly different. Below the water-level the ore consists of sulphurets of unspecified composition; above the water-level it carries horn-silver, some gold, a little lead, and manganese. In the Eldorado district there are mines in a massive rock, probably diorite, which carry argentiferous copper minerals.

LINCOLN.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	WALLS.		Character of deposit.
		Foot.	Hanging.	
BRISTOL.				
Hillside	Galena and cerussite and (limestone)	Limestone	Limestone.	
Independence		Quartz-porphyry and shale	Granite.	
Mendha	Galena and decomposition products		Limestone.	
ELDORADO.				
January	(Horn-silver), iron oxide	Probably diorite	Probably diorite.	
Savage	Stromeyerite, quartz, and calcite	Granite*	Granite*	Vein.
JACK RABBIT.				
Day	Argentiferous galena and lead carbonate, red copper ore and malachite, manganese oxide, (calc-spar and iron oxide).	Limestone	Limestone	Pockets.
ELY.				
Meadow Valley	(Gold, horn-silver, quartz, iron oxide, and manganese oxide.)	(Quartzite)	(Quartzite)	Vein.
Raymond & Ely	do	do	do	Do.
Brooklyn	Galena, zincblende, iron pyrites, (antimonial silver and quartz).	Siliceous limestone	Siliceous limestone.	

* Microscopically examined.

NYE COUNTY.

Argentiferous lead ores, inclosed in limestone in the usual irregular masses, veins of silver and copper ores, accompanied by slate or granite as well as limestone as wall rocks, and veins of arsenical and antimonial silver ores, inclosed in quartz-porphyry, are all found in Nye. The famous Belmont mine is on a vein in Silurian slate which lies between granite and limestone. The vein is conformable with the slate, and carries sulpho-salts of copper, silver, and lead.

NYE.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
BELMONT.				
Belmont	Galena, probably stephanite, quartz, pyrite, (sulphurets of lead, copper, and silver).	Slate between granite and limestone.	Slate	Vein.
MONEY.				
Bay State	Sulphurets, arsenical and antimonial silver minerals and mispickel.	Quartz-porphyry*	Quartz-porphyry*	Vein.
Kaiser	Ruby silver and sulphurets, arsenical and antimonial silver minerals, and manganese spar.	do	do	Do.
Magnolia	do	do	do	Do.
TYBO.				
Tybo Consolidated	Galena and decomposition products, (horn-silver, iron oxide, quartz, and argentite).	Limestone	Limestone	Contact vein.
UNION.				
Alexander	Galena, horn-silver, (copper ores, native silver, limestone, and quartz), shale, sinchlende, and iron oxide.	Limestone	Limestone	Mineral belt.

* Microscopically examined.

STOREY AND LYON COUNTIES.

The only mines of importance in these counties are those of the Comstock lode, of which sufficient mention has been made. There are, however, other silver-bearing veins in eruptive rocks of this region, though none which have yielded large and steady profits.

STOREY AND LYON.

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
THE COMSTOCK				
Utah		Diorite*	Diorite*	Vein.
Peytona	Auriferous quartz	do*	do*	Do.
Sierra Nevada	Quartz, argentite, native silver, and gold, occasionally stephanite, polybasite, etc., iron and copper pyrite, rarely calcite.	Diorite*	Diabase*	Do.
Union Consolidated				
Mexican				
Ophir				
California				
Consolidated Virginia				
Best & Belcher				
Gould & Curry				
Hale & Norcross				
Chollar				
Potosi				
Bullion				
Exchequer				
Alpha				
Challenge				
Confidence				
Yellow Jacket	Quartz, argentite, native silver, and gold, occasionally stephanite, polybasite, etc., iron and copper pyrite, rarely calcite.	Black slate*	Diabase*	Do.
Kentuck				
Crown Point				
Belcher				
Overman	do	Quartz-porphyry,* diorite,* and metamorphics.*	Diabase in part*	Do.
Alta	do	do	Diorite* and andesite*	Do.
Justice	Rebellious silver ores in calcareous gangue	Quartz-porphyry* and metamorphics.*	Diorite* and andesite*	Do.

* Microscopically examined.

WHITE PINE COUNTY.

The famous deposits of the White Pine district consist largely of horn-silver in irregular bodies in Devonian limestone. The chloride is accompanied by some lead minerals, however, and these predominate in the deposits of the base metal range near by. It is possible that the horn-silver of the Eberhardt & Aurora is a product of the decomposition of argentite, and it is distinguished from ordinary occurrences in limestone by the presence of large quantities of quartz gangue, but the admixture of lead minerals suggests that the ore bodies may be nearly related to the class of which the Eureka deposits are representative. There are also veins in the county associated with slate and massive rocks as well as limestone. These for the most part carry copper, besides silver and some gold. In the Robinson district there are mines the ore of which is smelted for copper. They carry gold and silver in addition to the copper, and may represent extreme cases of the mineralogical association last mentioned.

WHITE PINE.

[NOTE.—Determinations in parenthesis are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
CHERRY CREEK.				
Exchange	(Horn-silver, argentite,) and quartz	Quartzite	Diorite (?)	Contact vein.
Star	(Pyrite, galena, stephanite, quartz, and calc-spar)	Slate	Slate	Vein.
Tickup	Copper carbonates, sulphurets, (horn-silver, and quartz)	Limestone	do	Contact vein.
NEWARK.				
Bay State	Probably tetrahedrite, with carbonates	Limestone	Limestone.	
WARD.				
Paymaster	Probably stromeyerite and sulphantimonides, quartz, calc-spar, pyrite, zincblende, and chalcopyrite.	Slate, limestone, and probably granite.	Limestone	Vein.
WHITE PINE.				
Eberhardt & Aurora	(Chloride, with siliceous limestone)	Limestone	Limestone	Impregnation.
Stafford	do	do	do	Do.

The remaining counties are of little importance at present. Washoe is one of the oldest mining counties, and contains base metal mines and silver veins, but its product is now very small, while the resources of Douglas, Ormsby, and Roop are undeveloped.

GEOLOGICAL SKETCH OF UTAH.

In northern Utah the Wahsatch range trends approximately north and south. It ends to the south about latitude 39° 30′, but is nearly continuous with the western edge of the high plateau, which sweeps to the westward as the latitude diminishes. Together they form the eastern limit of the Great Basin, and divide Utah into two unequal parts, of which the western is the smaller. These two portions of the territory differ greatly. The Great Basin in Utah is characterized by the presence of the Great Salt lake and extensive areas of especially desolate alkaline desert, as well as by the system of mountain ranges mentioned in the description of Nevada. To the east of the basin lies an elevated area, of which the distinguishing characteristic is the horizontality of its strata. The general character of this region is that of a great undulating plain, though it is not utterly devoid of hills. Its soft surface is deeply carved by modern streams into fantastic pinnacles and bluffs, which, added to the prevailing extreme barrenness, gives it a strange aspect, and a large portion of it has received the significant name of "bad lands". This plain is broken in latitude 40° 30′ by the great eastern and western ranges of the Uintah mountains, which are 150 miles long, and rises at its culminating point, Emmons peak, to an elevation of about 13,700 feet. It is unlike any other range in America, being, in fact, a lofty forest-covered plateau, from which rise bare rocky peaks, composed, like the plateau, of nearly horizontal strata. It divides the Green River basin from the great plateau basin of the Colorado, but is cut through by the Green river. These two areas share the characteristics just described.

The mineral resources of Utah are extensive and varied, and comprise lead, silver, gold, copper, coal, iron, salt, sulphur, etc.

All the government surveys have done more or less work in Utah, but so far as the mining regions are concerned the chief sources of information are the publications of the exploration of the fortieth parallel and the geological volume of Captain Wheeler's survey. Dr. J. S. Newberry has printed important papers on the subject, and Mr. G. K. Gilbert has published a paper on lake Bonneville. (*a*)

The Wahsatch forms the boundary between two distinct geological regions. At the close of the Carboniferous the western portion of the Great Basin (including the area of the Wahsatch) was raised above the level of the

a Second Annual Report Director United States Geological Survey.

ocean, a position which it maintained throughout the Mesozoic era. The region to the east of the Wahsatch, on the other hand, remained undisturbed during the Trias and Jura, and underwent only gentle changes of elevation during the Cretaceous. The post-Jurassic upheaval, which folded up the Sierra Nevada and the Basin ranges, probably also had its effect upon the Wahsatch, but extended no farther. At the end of the Cretaceous a vast upheaval took place in the heart of the country, by which the whole system of the Rocky Mountain ranges was raised substantially to its present position, displacing the great gulf which had hitherto occupied this area. In this uplift the Wahsatch was involved, as is known, by the plication of the Cretaceous strata on its eastern slope; but the effect of the movement is not traceable further to the west. The Wahsatch range thus belongs geologically both to the system of the Basin ranges and to the Rocky Mountain system, and forms a broad boundary wall between the two.

A great fault has taken place at the western side of the Wahsatch, which forms its foot wall. Had erosion not modified the range, it would be seen to consist of Mesozoic and earlier strata continuous with those of the country east of it but bent upward near the fault-plane, so that on the west of the crest there would be a gigantic cliff, cutting the strata nearly at right angles, while the eastern face would slope steeply away from the crest, but would gradually flatten and pass over into the nearly horizontal surface of the plateaus. To the south of the Wahsatch the plateau country was also elevated at the close of the Cretaceous, but its uplift was not attended or followed by any horizontal thrust sufficient to flex the strata near the line of upheaval into mountains. The Uintah range likewise dates from the post-Cretaceous uplift, and indicates a northern and southern compression, for its character is that of a broad anticlinal. Since the post-Cretaceous there have been further orographical changes, though none which have introduced new topographical features of importance.

The great Wahsatch fault is a feature of the geology of Utah which has probably had an important influence on many of its geological phenomena, including that of mineral deposition. The geologists of the fortieth parallel have shown that, as far back as the Archæan, a fault occurred along the range coinciding for the most part with its present western foot. Renewed dislocation on the same plane occurred at the close of the Cretaceous or early in the Eocene, again in the Quaternary, and the fault appears to be in progress even at the present day, for so fresh is the most recently exposed surface that vegetation has not had time to clothe it. The observers draw the inference that such fractures in the earth's crust always remain lines of weakness, liable on comparatively slight occasion to further dislocation.

During the Trias-Jura the gulf or inland sea, of which the Wahsatch formed the western shore, was shallow in the northern and central portions of Utah, and the sediments consist of sandstones and shales, often cross-bedded by the action of currents. Numerous pools seem also to have been cut off from the main body of the water, and thus to have been exposed to evaporation. The result is seen in frequent gypsum deposits, which are, for the most part, thickest at the center and thin out toward the edges. Such conditions are not favorable to marine life, and a very large part of the strata representing the Trias-Jura contain only fragments of vegetation from surrounding coasts. At the southern end of the territory during the Jurassic the sea was deep and deposited calcareous sediments.

During the Cretaceous the water was for the most part shallow toward the north, and, in consequence of gentle oscillations in level, land and sea frequently alternated on the eastern side of the Wahsatch. Portions of the country, however, were maintained long enough above sea-level to permit of the growth of an extensive flora, and, as a consequence, the Cretaceous strata are marked by the presence of numerous carbonaceous beds, which often contain coal seams of fair thickness. In southern Utah the Cretaceous sea at certain points was deep, but throughout the plateau area most parts of it were shallow.

After the post-Cretaceous uplift, and throughout the Tertiary, the region east of the Wahsatch was occupied by great fresh-water lakes, the sediments of which toward the north, and especially near the Uintah range, are deposited unconformably on the Cretaceous. In this region they are also unconformable among themselves, showing that orographical changes took place during their deposition. In southern Utah, however, the Tertiary fresh-water strata appear to show no non-conformity either with one another or with the underlying Cretaceous. It is these fresh-water Tertiaries which have been modeled by modern streams into the fantastic forms characteristic of the bad lands. Several large lakes existed in the Great Basin during this era, and similar conditions prevailed through the Quaternary, modified only in more recent times by slight orographical changes and by greatly increased evaporation. The great Quaternary lake of Utah was Bonneville, the history of which has been studied by Mr. G. K. Gilbert. According to that geologist the present dry period in the Great Basin is not the only one which it has experienced. A long remote period of drought, during which the lake sometimes nearly or quite dried up, was succeeded by a long wet period, in which, however, there was an insufficient supply of water to permit an overflow. Next came a time so dry that the lake altogether disappeared, and then one of so much precipitation as to allow of discharge by overflow. This was followed by the present epoch, in which the area of water has been reduced to that of the Great Salt lake and the smaller bodies south of it. (*a*)

The eruptive rocks of western Utah are the same as those of Nevada, and are represented by Archæan granites, Mesozoic diorites, diabases, etc., and Tertiary or post-Tertiary andesites, rhyolites, and basalts. According to Mr. Hague, no true trachytes are found among the rocks collected in Utah by the exploration of the fortieth parallel.

a Second Annual Report of the Director of the United States Geological Survey.

An interesting series of rocks, locally called ayenitic porphyries, has been collected in the West Mountain district, Oquirrh range, by the census expert, which seem to be highly augitic granite-porphyries. As in Nevada, there is an intimate relation between the ore deposits and occurrences of eruptive rocks, the former seldom being found except in the immediate neighborhood of the latter.

Metallic ores are rare east of the Wahsatch and in the plateau country, where indeed Tertiary strata occupy much of the surface. In southern Utah, however, the Triassic sandstones carry silver and copper, and especially rich strata of this age form the famous silver reefs near Leeds. To the west of the Wahsatch and along the edge of the high plateau a series of ore deposits is found from one end of the territory to the other, forming a true mineral belt. All of these are associated with Palæozoic strata, which, however, proves nothing as to the age of the deposits; indeed, it is known that some of them must be Tertiary or post-Tertiary. It seems extremely probable that these ore deposits owe their existence to the solfataric action accompanying the eruption of massive rocks, and that the points where these reached the surface were determined by the line of disturbance, of which the great Wahsatch fault is the most striking manifestation. At all events, it is a fact that the western edge of the post-Cretaceous uplift is marked in Utah by an immense number of deposits. It has been pointed out on a preceding page that there is a strong analogy between the geological relations of the mineral belt of Utah and those of California. There are ores in the Basin ranges of Utah as well as near the Wahsatch, and particularly in the Oquirrh mountains, which lie to the west of Utah lake. These are very similar to the deposits in the kindred ranges of Nevada.

The prevailing type of the ore deposits in Utah consists of more or less regular bodies of argentiferous lead ores associated with limestone, and usually accompanied by eruptive rocks. The original form of the ore was probably in all such cases galena, which in a majority of instances has yielded to decomposition processes for a long distance from the surface, and is now replaced by carbonate, sulphate, and other secondary minerals. Of such occurrences the Horn Silver mine is an excellent type and an important instance. The deposit worked by this mine lies between a foot wall of dolomitic limestone and a hanging wall of rhyolite. The nature of this lava is proved by microscopic slides in the census collection. Small masses of galena occur, but the prevalent mineral is the sulphate which has formed in consequence of oxidation of the galena. It is a significant fact that heavy spar is one of the gangue minerals, but occurs only near the rhyolite. The same district shows other volcanic rocks. An augite-andesite is found near the Horn Silver mine, and the Carbonate mine, near by, is associated with a hornblende-andesite of so-called "trachytic" habitus similar to the Mount Rose hornblende-andesite of the Washoe district.

The veins in Utah which are associated with slates or quartzites do not commonly carry a preponderance of lead ores, but are cupriferous and sometimes auriferous; the gangue in such cases is also generally quartz. Of such mines the Ontario is much the most important.

The Ontario mine in the Uintah district, Summit county, is a strong vein, several feet wide. Its ores are zincblende, galena, fahlerz, and pyrite, with some horn-silver and copper carbonate in a quartz gangue. The walls are, in the main, quartzite, but at 400 feet a porphyry was struck near the vein which appears at lower levels in contact with the vein, and it is thought will replace quartzite as the hanging wall. Unfortunately the specimens of this porphyry received are too much decomposed to make determination possible. It is full of pyrite, and has manifestly been subjected to solfataric action. The Ontario is one of the richest mines in the country. Its ore is treated by roasting in a Stetefeldt furnace and amalgamation.

The sandstones of southern Utah and the adjoining regions carry a very unusual form of ore deposits, consisting of impregnations of silver and copper, partly native and partly as sulphides. Much of the silver sulphide has also been converted into chloride. The age of these sandstones was determined by Professor J. Marcou, and subsequently by Dr. J. S. Newberry, as Triassic—a determination confirmed by Messrs. Gilbert and Howell. (*a*) The geological information which has been published on this subject is very largely due to Dr. J. S. Newberry. (*b*) After having described the peculiar character of the Triassic sea in this portion of the continent and mentioned the well-known facts regarding the silver contents of ordinary sea-water, this geologist states his opinion as to the origin of the silver and copper in the sandstones as follows:

> Near the Utah shore of this Triassic basin the water would seem to have been more highly charged than elsewhere with silver, though it was also the associate of the more abundant copper in New Mexico, the Indian territory, and Texas. Doubtless this silver was brought up in springs on the old land from the same sources which furnished so large an amount of silver to the fissure veins formed there long after. Near the old shore the drift-wood brought down by the draining streams and scattered by the shore-waves, when buried in the accumulating sediment, became more or less replaced by copper and silver, precipitated by the reducing action of organic matter which is manifested in so many different ways. The quantity of silver in some of the bays and estuaries carried by draining streams, perhaps fed in part by mineral springs, may have been greater than that in most parts of the water-basin, and hence the sediments formed there hold a quantity larger than the average. We find the same variation in the distribution of copper farther east. In some places it was so abundant that it was not all taken up by the decaying wood, but formed concretions of sulphide in the sand or clay.
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> * * * * * * * * *
>
> The ores of silver and copper plainly existed as solutions, which saturated the sand when it was collected and deposited the sulphides with sandstone after the mechanical action which transported the sediment was at an end. All this, however, was within the Triassic age, while the water was shallow and highly charged with mineral matters.

a *Surveys West of the 100th Meridian*, vol. 2, p. 176. *b* See especially *Engineering and Mining Journal*, vol. 31, p. 5.

He states later in the same article that he regards it as possible, though not probable, that in some places the porous sandstones of the Trias were penetrated by solutions, from which the sulphides of copper and silver were precipitated.

The undisturbed condition of some of the sandstones is certainly an argument in favor of the supposition that the ore was deposited with the sandstone, but there are considerable difficulties involved in its acceptance. Common sea-water will dissolve only an extremely small amount of silver salts, though saturated solutions of salt are capable of dissolving silver chloride in considerable quantities. If the Triassic sea held the silver in solution, it can only have been charged with the metal after isolation from the main ocean and concentration by evaporation; but it is difficult to suppose this combination of conditions prevailing over wide areas. The deposits of commern in Rhenish Prussia present very strong analogies to those of Silver Reef, but there it is an argentiferous, though otherwise very pure galena, which is disseminated through sandstone. There are strong chemical objections to supposing this galena to have been deposited directly from the ocean, or even from a land-locked basin of concentrated sea-water; yet a satisfactory theory would give an account of it as well as of the Utah silver. The theory of impregnation of the sandstones by solution presents, in my opinion, fewer difficulties. It is not easy to see why the replacement of organic matter, such as wood, by the metals would not occur as readily from an ascending solution as from sea-water, while ascending solutions would certainly favor the formation of the considerable nodules of ore sometimes found in the sandstone. May these deposits not, after all, be chemically and physically analogous to ordinary veins, though so different from them structurally? It is supposed that precipitation takes place in veins where there is room for deposition, and where at the same time relief of temperature and pressure or chemical action, especially that of organic matter, induce precipitation. In ordinary rocks such conditions are to be found mainly in fissures, but in sandstones, particularly such as carry organic matter, they may occur anywhere, and the presence of copper or lead would be as readily accounted for as that of silver. Dr. Newberry records that analyses made at his instance by Mr. J. R. Mackintosh show that the silver in some of the sandstones is accompanied by selenium in considerable quantities.

The number of workable coal-seams in Utah is very considerable. Those thus far opened lie for the most part on the eastern flank of the Wahsatch, or not far from the western edge of the high plateau, and while search for them elsewhere is by no means hopeless, these localities seem most likely to show good seams. Both Cretaceous and Tertiary beds are said to occur, (*a*) and some of them are reported to present very unusual qualities for coals of such recent date, not crumbling on exposure, containing a very small amount of water, and yielding strong coke. The great value of such beds, at an immense distance from the well-explored coal-fields of the Carboniferous era, is patent.

In the appendix will be found a report on the mining industries of Utah by Mr. D. B. Huntley, who filled the office of special expert for the territory. This paper describes the mineral resources in so much detail that any special notes on the counties are unnecessary here.

BEAVER.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
BRADSHAW.				
Cave	Cerussite, cuprite, copper carbonates, with calcite, aragonite, and limonite, (manganese oxide, native sulphur).	Limestone	Limestone	Irregular bodies.
SAN FRANCISCO.				
Horn Silver	Cerussite and anglesite predominate; galena, dufrenoysite, proustite, (pyrargyrite), cerargyrite, argentite also occur with calcite, quartz, and barite.	Limestone	Rhyolite *	Chimney.
Carbonate	Argentite, argentiferous galena, cerussite, and quartz.	Hornblende-andesite *	Hornblende-andesite *	Vein.
Grampian	Galena, cerussite, and calcite, (iron oxides and quartz).	Limestone	Limestone	Irregular bodies.
Makaiola & Summit	Copper carbonates, calcite, (iron oxides, said to carry fluorspar).	Limestone and slate	Limestone and slate	Pipes.
STAR.				
Burning Moscow Hill	Cerussite	Black limestone	Black limestone.	
Cressna	Cerussite, horn-silver, malachite, and quartz	Limestone	Limestone.	
Harrisburg	Galena, cerussite, gypsum, and pyrolusite, (limonite)	Dolomitic limestone	Dolomitic limestone	Chimney.
Osceola	Cerussite and quartz	Siliceous limestone	Siliceous limestone.	
Rebel	Galena, (cerussite and iron oxides)	Limestone	Limestone.	
Vicksburg	Galena, cerussite, free sulphur, gypsum, and quartz, (limonite).	Crystalline limestone	Crystalline limestone.	
Vulcan	Hematite and limonite used as flux	Granite *	Limestone.	
Wasco	Galena, cerussite, and clay, (limonite, little gold, or silver).	Dolomitic limestone	Dolomitic limestone	Chimney.

* Microscopically examined.

a E. E. Howell in *Surveys West of the 100th Meridian*, vol. 3, p. 278.

JUAB.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	WALLS.		Character of deposit.
		Foot.	Hanging.	
TINTIC.				
Bonanza	(Galena, pyrite, and other minerals)	(Porphyry)	(Porphyry)	Pipes.
British	(Copper minerals, limonite, calcite, quartz, rarely gold, and manganese oxide.)	(Limestone)	(Limestone)	Mineral belt.
Carisa	Quartzose, carrying limonite and lead, probably as cerussite, (copper carbonates and sulphides).	Probably dacite,* (limestone).	Probably dacite,* (limestone).	Vein.
Elmer Ray	Erubescite, anglesite, pyrite, mispickel, quartz, (limonite).	Hornblende-andesite*	Hornblende-andesite*	Do.
Eureka Hill	Galena and its decomposition products, copper stains, hematite, quartz, calcite, (lead ocher, gold, horn-silver, and zincblende).	Siliceous limestone	Siliceous limestone	Irregular masses.
Golden Bell	Bismuthite (argentiferous).			
Golden Treasure	Siliceous and ferruginous rock (carries bismuth and silver).	Indeterminably decomposed massive rock.	Indeterminably decomposed massive rock.	Vein.
Joe Bowers	Ferruginous quartz, calcite, and cerussite (?)	Andesite, (?) decomposed and pyritiferous.	Andesite, (?) decomposed and pyritiferous.	
Mammoth	Cuprite, pyromorphite, copper carbonates, quartz, calcite, pyrolusite, (limonite, argentite, and horn-silver).	Dolomitic limestone	Dolomitic limestone	Vein.
Mammoth Copperopolis	Enargite, malachite, quartz, pyrolusite, (silver)	Limestone	Limestone.	
Morning Glory	Anglesite, iron oxide, and quartz.			
Park	Galena, cerussite, quartz, (limonite and silver, probably as argentite).	Diorite*	Diorite*	Vein.
Rising Sun	Argentiferous pyrolusite, (galena, gold, and copper)	Hornblende-andesite*	Hornblende-andesite*	Do.
Shower	Galena, cerussite, calcite, and quartz.			
Swansea	(Galena, cerussite, limonite, and quartz)	(Granite) (?)	(Granite) (?)	Do.

* Microscopically examined.

PIUTE.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

OHIO.				
Bully Boy	Galena, quartz, (cerussite).			
Copper Belt	Melaconite, (?) copper carbonates, iron oxide, (tetrahedrite, chalcopyrite, chalcosite, and quartz).	Quartz-porphyry*	Quartz-porphyry*	Vein.
MOUNT BALDY.				
Deer Trail	Galena and decomposition products, malachite, wulfenite, quartz, (lead ocher and copper sulphides).	Quartzite	Limestone	Contact vein.
Green-Eyed Monster	do	do	do	Do.
Pluto	Argentite, free gold, and calcite.			
Lucky Boy	Quicksilver selenide.			

* Microscopically examined.

SALT LAKE.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

BIG COTTONWOOD.				
Anollie	Melaconite and malachite, (lead, silver, and gold)	(Limestone)	(Limestone).	
Antelope & Prince of Wales	Galena, limonite, copper stains, and calcite, (cerussite and manganese oxide).	Limestone	Limestone.	
Butte	Galena, limonite, calcite, pyrolusite, and quartz	do	do	Vein.
Carbonate	Galena, cerussite, limonite, and calcite	Dolomitic limestone	Dolomitic limestone.	
Maxfield	Galena, cerussite, malachite, pyrite, quartz, calcite, talc, (manganese oxide and limonite).	Limestone	Limestone	Bedded vein.
Ophir	Galena, cerussite, copper stains, pyrolusite, and iron oxide.	Blue limestone	Blue limestone.	
Reed & Benson	Cerussite, plumbic ocher, anglesite, and calcite.	Limestone	Limestone.	
Silver Mountain	Galena, cerussite, plumbic ocher, (copper stains, quartz, and limonite).	Quartzite and shale.	Quartzite and shale.	Bedded vein.
Thor & Bright Point	(Galena, cerussite, limonite, and quartz)	Quartzite	Quartzite	Vein.
LITTLE COTTONWOOD.				
Cincinnati	(Galena), cerussite, anglesite, and pyrolusite.			
City Rocks	(Galena), cerussite, wulfenite, cuprite, malachite, pyrolusite, and limonite.	Limestone and diorite*	Limestone and diorite.*	
Dexter	Galena and quartz.			
Emma	Galena, cerussite, anglesite, limonite, calcareous gangue, (manganese minerals).	Limestone	Limestone	Belt.
Emily	Galena, dufrenoysite, pyrite, calcareous gangue, (tetrahedrite, zincblende, and quartz).	(Quartzite)	(Quartzite)	Vein.
Equitable	(Galena and cerussite)	(Limestone)	(Limestone).	
Evergreen	(Galena, cerussite, limonite, and copper carbonates)	(Limestone and sandstone)	(Limestone and sandstone).	
Grizzly	Cerussite, copper stains, limonite, and manganese minerals.	Limestone	Limestone.	
Louise	(Limonite, quartz, with galena and cerussite)	(Limestone)	(Limestone)	Vein.
North Star	Galena, cerussite, and wulfenite	Limestone	Limestone	Vein or belt.

SALT LAKE—Continued.

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
LITTLE COTTONWOOD—cont'd.				
Oxford & Geneva	Galena, cerussite, plumbic ocher, wad, enargite, pyrite, chalcopyrite, malachite, marcasite, calcareous gangue, (oxide of manganese and quartz).			
Toledo	(Hematite, quartz carrying silver)	(Quartzite)	(Quartzite)	Vein.
Vallejo	Galena, cerussite, anglesite, copper stains, limonite, hausmannite, and wulfenite.	Dolomite	Dolomite.	
Victoria & Surpriser	Cerussite, limonite, probably horn-silver.			
Wellington	Galena, zincblende, copper pyrite, (limonite, silver, and gold).	(Black limestone)	(Black limestone)	Vein.
WEST MOUNTAIN.				
Highland Boy	Galena, chalcopyrite, (gold)	Quartzite	Limestone.	
Jordan	Galena, (gold), iron and copper pyrites, cerussite, limonite, quartz, and copper stains.	....do	Siliceous limestone	Vein.
Live Yankee	Galena, cerussite, limonite, and quartz	Granite-porphyry*	Granite-porphyry.*	
Lucky Boy	Orpiment and realgar.			
May Flower	Gold, quartz, and limonite	(Between granite and quartzite.)	(Between granite and quartzite.)	Vein.
Neptune	Zincblende, galena, pyrite, (silver and gold)	Limestone	(Quartzite).	
Old Telegraph	Galena, cerussite, iron and copper pyrites, malachite, limonite, and quartz.	....do	Quartzite	Belt.
Queen	Galena, cerussite, argentite, pyrargyrite, rhodocrosite, zincblende, quartz, barite, (bornite, calcite).	Augitic granite - porphyry. (?)*	Augitic granite - porphyry. (?)*	Vein.
Stewart	Gold, quartz, limonite, galena, and chalcopyrite	Quartzite	Quartzite	Bedded vein. (?)
Stewart No. 2	Gold, quartz, limonite, (silver and copper carbonate)	(Unknown)	....do	Vein.
Telegraph 1st W. Extn	Cerussite, quartz, (galena and limonite)	(Quartzite)	(Quartzite)	Bedded vein.
The Lead Mine	Cerussite and quartz	Quartzite	Quartzite	Belt.
Tiewaukee	Galena, binnite, zincblende, pyrite, cerussite, quartz, iron oxides, (ruby silver and native silver).	....do	....do	Do.
Victor	Cerussite, (silver and gold)	(Quartzite)	(Quartzite)	Vein.
Winnamuck	Galena, dufrenoysite, iron and copper pyrites, cerussite, limonite, zinc-vitriol efflorescence, native sulphur, (zincblende, cubanite, tetrahedrite, calcite, and gypsum).	Quartzite	Shale	Bedded vein.
Yosemite	Galena, cerussite, iron and copper pyrites, melaconite, limonite, (bornite, zincblende, and quartz).	....do	Quartzite	Vein.

* Microscopically examined.

SUMMIT.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

UINTAH.				
Empire	(Horn-silver), malachite, (cerussite), quartz, manganese oxide, and limonite.	Quartzite	(Said to be porphyry)	Vein.
Fairview	Cerussite, plattnerite (?) with calcareous gangue	(Quartzite)	(Quartzite).	
Ontario	Galena, argentite, (native silver), tetrahedrite, zincblende, (pyrite), horn-silver, malachite, clay, (quartz).	Quartzite	Quartzite and indeterminable diorite-like porphyry.	Vein.
White Pine	Galena, zincblende, pyrite, cerussite, malachite, (tetrahedrite, argentite, and native silver).	Limestone	Diabase (?)	Do.
Walker & Webster	Galena, cerussite, and quartz.			
Boss	(Zincblende, galena, cerussite, horn-silver, copper carbonate, manganese oxide, limonite, and quartz.)	(Siliceous limestone)	(Green porphyry)	Vein.
Woodside	(Cerussite, anglesite, galena, iron oxide, and calcite)	(Quartzite)	(Siliceous limestone)	Vein. (?)

TOOELE.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

CAMP FLOYD.				
Carrie Steele	Stibnite, quartz, limonite, (horn-silver and antimonial silver).	Limestone	Siliceous limestone	Bedded vein.
OPHIR.				
California	Cerussite and limonite	(Limestone)	(Limestone)	Bedded vein.
Douglas	Galena, cerussite, calcite, quartz, and limonite	....do	....do	Bedded mass.
Gem, Antelope	Galena, chalcopyrite, (limonite and pyrite)	....do	....do	Vein.
Hidden Treasure	Galena, cerussite, malachite, and limonite, (silver)	Limestone, quartz-porphyry	Slate dike	Chimneys.
Kearsarge	(Argentiferous galena, cerussite, copper carbonates, native silver, horn-silver, and limonite.)	Siliceous limestone	Sandstone	Irregular bodies.
Monarch	Cerussite, horn-silver, and siliceous gangue	Limestone and quartzite	Indeterminable porphyry	Bedded vein.
Mono	Galena, cerussite, plattnerite, (?) pyrite, (horn-silver, chalcopyrite, and limonite).	(Clay shale, close to limestone.)	(Clay shale, close to limestone.)	Vein.
Queen of the Hill	Galena, tetrahedrite, cerussite, malachite, limonite, and calcite.	Fetid limestone	Calcareous sandstone	Do.
Trace	Cerussite, limonite, and calcite, (the limonite is argentiferous).	Limestone	Limestone	Do.
Zella group	(Cerussite, horn-silver, limonite, and calcite)	....do	....do	Pipes.
RUSH VALLEY.				
First National	Galena, cerussite, limonite, (manganese minerals and copper stains).	(Siliceous limestone)	(Black limestone)	Bedded vein.
Great Basin	Cerussite, limonite, clay, (argentiferous galena, malachite, and manganese minerals).	Limestone	Limestone	Do.

UTAH.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	WALLS.		Character of deposits.
		Foot.	Hanging.	
AMERICAN FORK.				
Live Yankee	Galena, pyrite, quartz, (silver, gold, zincblende, and copper ore).	(Quartzite)	(Quartzite)	Vein.
Miller	Galena, cerussite, zincblende, pyrite, limonite, (silver, gold, and quartz).	Shale	Limestone	Do.
Pittsburgh	(Galena, cerussite, limonite, and clay)	(Limestone)	(Limestone)	Do.
Wild Dutchman	Galena, cerussite, zincblende, quartz, limonite, arsenical and antimonial compounds.	Limestone	Limestone	Do.
Treasure	(Cerussite, pyrite, quartz, limonite, and copper stains.)	do	do	Do.
SILVER LAKE.				
Milkmaid	Galena, cerussite, quartz, limonite, (pyrite and zincblende).	Quartzite	Quartzite	Pipes.
Wahsatch	(Galena, cerussite, limonite, and quartz)	(Quartzite)	(Quartzite)	Pockets.

WAHSATCH.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

BLUE LEDGE.				
Lady of the Lake	Galena, zincblende, calcite, and quartz	Granite *	(Porphyry)	Vein.
Wahsatch	Galena, cerussite, pyromorphite, and quartz	(Quartzite)	(Quartzite)	Do.
SNAKE CREEK.				
Jones Bonanza	Malachite, limonite, calcite, and (quartz)	Granite *	Granite *	Vein.
Pioneer	(Galena, cerussite, limonite, copper stains, and clay)	(Quartzite)	Shale	(?)
Utah	Galena, cerussite, zincblende, pyrite, clay, and (tetrahedrite).	Quartzite	Decomposed diorite (?) *	Vein.

* Microscopically examined.

WASHINGTON.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

HAWKINSBURG.				
Buckeye	Magnesian clay, showing flakes of silver. Sandstone with native silver and argentite. Fossil plants replaced in part by silver and horn-silver.	Sandstone and clay slate	Sandstone and clay slate	Bed.
Barbee & Walker	Sandstone with native silver and sulphurets, (horn-silver, argentite, and lignite).	Sandstone	Sandstone	Do.
Duffin	Sandstone containing horn-silver, (argentite, and native silver).	do	do	Do.
Kinner	Sandstone containing horn-silver and sulphurets, (silver, argentite, and lignite).	do	do	Do.
Leeds	(Horn-silver, argentite, native silver, carbonized vegetable matter.)	do	do	Do.
Maud	do	do	do	Do.
Stormont	do	do	do	Do.

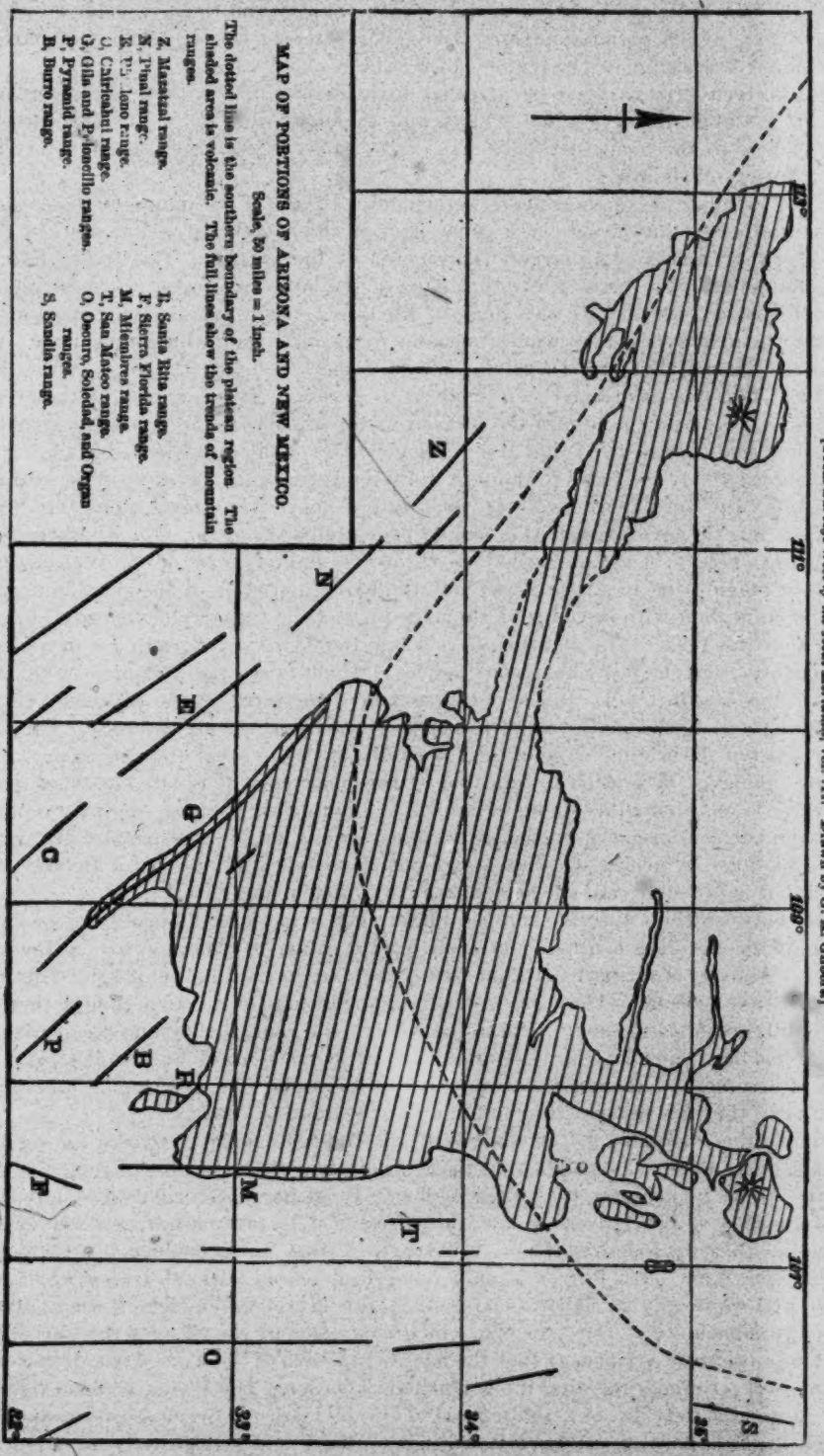
GEOLOGICAL SKETCH OF ARIZONA.

In the latitude of Salt Lake the Cordilleras, as Humboldt called the entire system of western North American mountains, occupy a breadth of over 1,000 miles. In the latitude of Tucson they are contracted to about half this width, which is still further reduced in Mexico. While Nevada occupies only a portion of the breadth of the Great Basin, Arizona, though no wider, includes a large part of the plateau region, the southern continuation of the Basin ranges, and probably a portion of the group of ranges of which those on the southern coast of California are members. The topography is thus extremely diversified and for the most part mountainous. There are fertile valleys and well-wooded mountains in the territory, but the prevalent character is one of great aridity, and in the southwestern portion there are large tracts of shifting sands, relieved only by occasional cactuses, in comparison with which the sage-brush plains of the Great Basin seem areas of luxuriant vegetation. Arizona is, of course, famous for its mines, which produce chiefly gold and silver, though lead and copper, particularly the former, are rather abundant, and will, no doubt, be exploited on a large scale when the railroad system is further developed. Coal also occurs in considerable quantities.

A number of geologists have visited Arizona. Dr. Newberry was a member of Lieutenant Ives's expedition in 1857; Major Powell and Captain Dutton have explored the Colorado cañon and a portion of the plateaus, and the geologists of Captain Wheeler's survey have contributed very greatly to a knowledge of the main features of the territory. But little detailed work, however, has been done in the mining regions, and such of the facts ascertained as are appropriate to this sketch are soon told.

Northeastern Arizona belongs to the Colorado plateau, of which about one-third falls within the limits of the territory. The Arizona plateaus are for the most part nearly level, though, as in Utah, there are folds, and even ranges, of uplifted mountains at long intervals.

The southwestern limit of the plateaus is roughly indicated by a straight line running northwest from a point in latitude 33° 30′, longitude 110°. To the east of this point the limiting line curves eastward, and in the



[From Survey West of the 100th Meridian, vol. III. Drawn by G. K. Gilbert.]

adjoining territory of New Mexico turns toward the north. The plateau country separates two systems of ranges which meet to the south of it. Of these the eastern group have a northern trend and pass into the Rocky mountains

of Colorado. The western group trends northwest, and is continuous with the Basin ranges of Nevada. Only the latter ranges are met in Arizona, the most westerly of those of northern trend occurring in New Mexico just east of the dividing line.

The region in which the plateaus and the two systems of ranges meet is characterized by an immense lava field covering between 20,000 and 25,000 square miles.

The relations of the two systems of ranges to the plateau country and the lava fields are shown in the sketch map on page 45, borrowed by his permission from Mr. Gilbert's report on the geology of parts of Arizona and New Mexico, to which our knowledge of the region in question is chiefly due.

Concerning southwestern Arizona there is extremely little definite information. This portion of the territory is mostly composed of granites and crystalline schists, and the mountain ranges are somewhat irregular. They appear, however, to belong to the same structural system as those of California south of fort Téjon, with which they correspond in a variety of details.

In Utah the edge of the plateau system is nearly coincident with that of the inland Cretaceous sea. In Arizona this is by no means the case, the surface of a great part of these elevated plains toward the west being of Carboniferous age, and the Triassic being largely represented on the surface. The belt of Palæozoic included in the plateau country, measured from the southwestern edge of the latter, averages about 80 miles in width. The ranges trending northwest and continuous with those of the Great Basin are also composed of Palæozoic strata, except where the Archæan is exposed or where volcanic rocks hide the sedimentary beds. Captain Dutton's investigations have established that the Jura-Trias strata formerly reached the edge of the plateau system in Arizona as they did in Utah, but have since been removed by erosion. This is shown by the presence of remnants of these beds protected by lava near the edge of the plateau, and by the impossibility of reconstructing their surface, except on the supposition that they reached this line. The elevation of the range system, judging from the analogy of the Great Basin, is most likely referable to the post-Jurassic disturbance which resulted in the formation of the Sierra Nevada. Whether the Jura-Trias beds were also raised above water-level along this line at this time is uncertain, but it would not be surprising if this should prove to be the case. The Cretaceous sea in Utah was shallow, and a slight post-Jurassic elevation would have thrown its shore far east of the Wahsatch. Such a change of shore line may have taken place in Arizona and left the western portion of the plateau dry, or the shore line may have been nearly coincident with the edge of the plateau, and the Cretaceous deposits afterward removed by erosion, like those of the Jura-Trias. The disturbance to which the Arizona ranges is due extended eastward to the edge of the plateau country, and the post-Cretaceous upheaval which raised the plateaus extended westward to the ranges, exactly as was the case in Utah. In the northern part of the territory the contact between the Palæozoic area and the crystalline rocks to the southwest of it has been traced for a long distance. This line probably lies somewhat to the northeast of the original edge of the Palæozoic, but at no great distance from it. That a portion of these strata have been removed by erosion is indicated by the occurrence of isolated patches near the main area. The most remote of these is reported as occurring in the Bill Williams Fork country, and may represent a gulf in the Palæozoic sea. Though the southwestern portion of the territory has not been systematically explored, it has been traversed in many directions by geologists who would not have failed to recognize Palæozoic strata had they encountered them, and it is probable that they are absent from that region.

The main contact between the Palæozoic and the underlying strata is laid down in the geological maps of the surveys west of the 100th meridian continuously from Virgin cañon to Camp Verde, a distance of 170 miles. Farther south the most westerly occurrences of Palæozoic shown are in the Pinal mining district near Florence and in latitude 32° 20′, longitude 109° 40′. These are probably near the edge of the area, though there is some evidence of detached patches still farther to the south, and to the west of the general course of the contact so far as traced. The Chiricahui range has been shown by Mr. Gilbert to be largely made up of Palæozoic strata, and the mines of the Tombstone district are many of them sunk on deposits in limestone. In this region limestones can hardly be other than Palæozoic, and they are reported as containing Carboniferous fossils.

The rocks adjoining the Palæozoic to the southwest are unquestionably Archæan, for their relations to the Silurian are clear at a great number of points, and their lithological character in this region is very characteristic and persistent. There seems no evidence that these Archæan rocks have been covered at any time, except where comparatively small patches of the Palæozoic have been removed by erosion near the contact. Had this area formed a sea bottom, like the corresponding region to the north, during the Trias-Jura, it is scarcely supposable that the thick sediments which must have formed should have disappeared without traces which would have been detected before now; and while only an elaborate field study can establish the facts, it seems allowable to suggest the probability that the subsidence of the Archæan, which took place at the close of the Carboniferous in western Nevada, did not extend to central Arizona, so that the continental area of the Trias-Jura embraced eastern Nevada, western Utah, and most of Arizona, excepting the northeastern corner. The Pacific coast of that time followed the meridian of 117° 30′ (approximately) to the neighborhood of Owen's lake. If the supposition stated above is correct, it must then have left the Palæozoic area and continued in a southerly or southwesterly direction. It appears most probable, on the whole, that it passed to the south of fort Téjon and out into the area at present covered by the Pacific. The coast in San Bernardino county, California, has no doubt slowly changed its elevation repeatedly, but

Professor Whitney states that, while in that county a belt of 10 or 12 miles next the coast is occupied by Cretaceous and Tertiary strata, the region back of this is composed of granite and highly crystalline rocks of the geological age, of which nothing is known. (a) Such descriptions of San Bernardino county as have been published, however, show that the rocks are extremely similar to the Archæan of Arizona, and in the absence of definite information it may be assumed that they are identical. If so, there is a body of Archæan reaching from San Diego to Camp Verde, a distance of about 300 miles. Its northern limit is not far from Owen's lake, and its southern extension is unknown. If the shore line of the Pacific ocean in the Mesozoic era passed westward or southwestward from near fort Tejon to the present coast, Jura-Trias strata probably underlie the coast ranges in that neighborhood, and it is possible that they may somewhere be exposed.

It is, of course, wholly impossible to assign a date to the Archæan ranges of Arizona, the more so that the topographical maps of the area are very inaccurate. These mountains scarcely appear to form a portion of the Basin range system, but they may have been raised at the same time, for, though their lithological character differs greatly from that which prevails in those ranges, the trend and general relations of the Archæan mountains certainly do not differ more from those of the Palæozoic ranges of Arizona than the Mesozoic Sierra Nevada from the ranges of the same era in western Nevada. It at least seems more likely that the Archæan ranges date from the post-Jurassic upheaval than from either of the three other important uplifts mentioned, while it scarcely seems possible that any traces of a pre-Palæozoic mountain formation should have withstood erosion till the present day unless protected by overlying rocks of later age.

Of the eruptive rocks of Arizona not much is known. Besides granite, there are enormous quantities of true basalt and of other volcanic rocks which have not yet been subjected to the minute examination necessary to classify them satisfactorily. The census collection contains numerous specimens of pre-Tertiary eruptive rocks, quartz-porphyry, diabase, and diorite. If the analogy of Nevada could be trusted, these rocks would be regarded as Mesozoic, and as probably post-Jurassic. They appear in the Palæozoic ranges, not merely as dikes, but as large masses, inclosing veins, and their extrusion was most likely a concomitant of the disturbance to which the formation of the ranges is due. Though only an examination in the field can determine the age of those mountains, the occurrence of these eruptives is another argument for referring them to the great Mesozoic upheaval.

The census collection of the Pacific division contains only a single syenite. This forms the hanging wall of the Golden Eagle mine, Globe district, Pinal county, Arizona territory. A slide shows orthoclase, a little plagioclase, hornblende, mica, and scarcely a trace of quartz. The exploration of the fortieth parallel encountered but one syenite. This was found in the Cluro hills, Cortez range, Nevada, and contains much more quartz than that from the Golden Eagle mine. The latter, however, bears a strong resemblance to the granite which is the prevailing rock in the Globe district, and is represented in the census collection by a large number of specimens. The Cluro Hills syenite is also scarcely distinguishable from the granite of the same region, and it may fairly be asked whether both are not to be considered as granites containing an unusually small proportion of quartz. As is well known, almost every fresh investigation of European syenites diminishes the number of occurrences to which the name is considered applicable, and it seems not unlikely that it will eventually disappear from the list of rocks.

The ore deposits of Arizona in a majority of cases are found in connection with massive rocks. Often both walls are granite or some later eruptive; in many cases a massive rock forms one wall of the veins, and even where limestone or shale entirely inclose the ore it is known in some cases that eruptive rocks occur close in the neighborhood. The relations of the mineral belt as a whole to the southwestern edge of the area of post-Carboniferous upheaval have already been sufficiently commented on.

APACHE COUNTY.

In the northern part of this county good coal seams exist in the Cretaceous, but at present they are little exploited for want of facilities for transportation. At the southern end of the county, where it adjoins Pima, copper ores, with blende and pyrite, occur in the veins associated with limestone and quartz-porphyry. There are also gold placer mines in the same neighborhood, and consequently there must be gold quartz veins, though none such have been reported by the experts.

APACHE.

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
COPPER MOUNTAIN.				
Longfellow	Melaconite and azurite, zincblende, pyrite, with calcareous gangue.			
GREENLEE GOLD MOUNTAIN.				
Boston group	Auriferous gravel	Probably diorite		Placer.
Coronado group	Malachite and cuprite, quartz gangue	Quartz-porphyry	Quartz-porphyry.	

a *Auriferous Gravels*, p. 18.

MARICOPA COUNTY.

Maricopa county includes a portion of the plateau country, and extends across the range system far into the Archæan area. The principal mining district in this county is the Globe, about half of which, however, lies in Pinal county. The principal ores are argentite and cupriferous minerals, associated with galena and zincblende. The ordinary gangue mineral is quartz, but heavy spar also occurs. The inclosing rocks are usually granite or highly metamorphosed strata, but the walls of the Mexican mine appear to be diabase. This district is nearly on the contact between the Palæozoic and the Archæan.

MARICOPA.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposits.
		Foot.	Hanging.	
GLOBE.				
La Plata	Argentite, erubescite, and chalcopyrite; gangue quartz and barite.	Metamorphic diorite*	Metamorphic diorite*	Probably vein.
Mack Morris	Copper glance; gangue quartz and barite	Granite	Granite	Do.
Mexican	Copper-stained, (carries lead, silver, copper, and zinc, which on the lower levels take the form of sulphurets; also gold).	Diabase	Diabase	Do.
Richmond West	Argentite, malachite, and cuprite	Granite	Granite	Do.
Silver Nugget	Malachite and azurite, accompanied by some sulpharsenide of copper, (also silver and horn-silver).	do	Do.	
Vulture	Galena, chrysocolla, malachite, stromeyerite, (gold)	Mica-schist	Mica-schist	Probably vein.

* Microscopically examined.

MOHAVE COUNTY.

Mohave county lies in the northwestern corner of Arizona. The best known district is the Hualapai, containing Mineral Park, which lies a few miles to the west of the Palæozoic area. The country rock of the Mohave county mines is almost exclusively granitic, but a gneissoid structure is said to be apparent in many cases. The ore occurs in veins with quartz gangue, and consists of argentite, stephanite, ruby silver, freibergite, etc., accompanied by galena, zincblende, and copper pyrite and mispickel.

Near the croppings these ores are largely converted into horn-silver and native silver, which are readily worked; but at some distance from the surface most of them become very base. Many disappointments in the working of Arizona mines have been due not to the exhaustion of the ore, but to the fact that below the water-level the ores were found to be rebellious. Such ores can be worked at a profit under the prevailing economical conditions only when very rich.

MOHAVE.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
HUALAPAI.				
Cerbat	Quarts carrying black sulphurets and green stains, probably of chloride of silver.	(Granite)	(Granite)	Vein.
Champion	Galena and its products of decomposition, gangue quartz.	do	do	Do.
Fairfield		Granite*	Granite*	Do.
Indian Boy	Ruby silver, zincblende, galena, and chalcopyrite			Do.
Keystone	Galena, zincblende, and chalcopyrite and pyrite, quartz gangue.	(Granite)	(Granite)	Do.
Lone Star	Ruby silver and indeterminable black sulphuret stains; quartz gangue.			Do.
Pure Metal	Galena and cerusite with quartz gangue	(Granite)	(Granite)	Do.
MAYNARD.				
American Flag	Galena, stephanite, argentite, zincblende, and iron and copper pyrites, (freibergite, native silver, and mispickel), quartz gangue.	(Granite)	(Granite)	Vein.
Peabody	Galena and coloradoes; quartz gangue.	do	do	Do.
Hackberry	(Silver chloride, argentiferous galena, and antimonial silver; quartz gangue.)	do	do	Do.

* Microscopically examined.

Hualapai district is very large, and contains a number of mineral neighborhoods. At Chloride veins occur in granite with quartz gangue. Near the surface the ore minerals are carbonate of lead and silver chloride. Below the water level these are replaced by galena and pyrite. The mines mentioned are: Schenectady, Schuylkill, Empire, Juno, Silver Hill, Pinkeye, Kanawha Belle, Oriental, and Porter. Near Stockton deposits are found which are similar to the foregoing, but they are reported as containing also native silver and ruby silver, as well as zincblende, chalcopyrite, and some stibnite. The mines mentioned are: Indian Boy, I. X. L., Tiger, Ed. Everett, Cupel, Dolly V., Pure Metal, Little Chief, Prince Geo., and Tigress. At Mineral Park native silver and silver chloride occur near the croppings of the veins which carry a quartz gangue and are inclosed in granite. The undecomposed minerals are argentite, ruby silver, stephanite, with some galena and zincblende, iron pyrite, and arsenical pyrite. The mines mentioned are: Keystone, Lone Star, Fairfield, Quick Relief, Conner, and Metallic Accident. At Cerbat the ore thus far mined carries horn-silver in a quartz gangue, with some native gold and silver, complex sulpharsenides, and antimonides and zincblende. The mines mentioned are: Cerbat, Black-and-Tan, Snowflake, Mocking Bird, Sixty-Three, Falstaff, Fontenoy, Champion, New London, Flora, and Paymaster.

The Maynard district, like the Hualapai, shows quartz veins in granite and mineral associations similar to that last mentioned. The mines reported are: The American Flag, Peabody, Dean, Antelope, and Mississippi.

The Cedar Valley district is also in a granite country. The ores are argentiferous galena, ruby silver, tetrahedrite, and, near the croppings, horn-silver, accompanied by zincblende, pyrite, and quartz. The mines mentioned are: Silver Queen, Hibernia, Hope, General Lee, Arnold, Billy Engle, Rainbow, Eugenie, Bunker Hill, Congress, and Gunsight.

Owens district is in a granite country, but a portion of the rock is gneissoid. The ores are argentiferous galena and argentite, with decomposition products near the croppings and a quartz gangue. The mines of the McCracken company and the Signal mine are the chief ones of the district.

PIMA COUNTY.

This county occupies the southern end of the territory, and crosses the mineral belt. It contains a very large number of districts, the most famous of which is Tombstone. Many of the mines in this district are in limestone, and carry chiefly argentiferous lead ores. Manganese minerals (pyrolusite and wad) sometimes accompany them in large quantities. There are also veins in the Tombstone district in quartzite. These carry cupriferous minerals more or less charged with silver and some free gold.

From mine reports and papers by Professor W. P. Blake it appears that the ore in the Tombstone district occurs in Palæozoic beds, probably of Carboniferous age, which have a prevailing inclination to the north and east, resting on a granitic base, which outcrops some distance to the southwest. These beds consist of a fine-grained quartzite, called by him novaculite, about 140 feet in thickness, underlaid by a light-colored dolomitic limestone and overlaid by a blue-black limestone passing into shaly beds. The principal portion of the ore is found at the horizon of this blue-black limestone. The sedimentary formations have been compressed into a series of sharp folds and fissured and traversed by dikes of pre-Tertiary eruptive rock, known in the district as diorite. The census collection from Tombstone contains both diorites and diabases. The general direction of the fissures and dikes lies between north and northeast. The ore occurs both in fissures which cross the strata either parallel to or in direct connection with the dikes and in bodies branching out from these approximately vertical bodies in a more horizontal direction, following in general the bedding planes of the formation, whose prevailing dip is to the northeast. The ore is most abundant and richest in that part of the black limestone beds which are contiguous to the quartzite, and the vertical fissures generally contract and become less rich where they cross the quartzite itself. Their continuation in the lower limestone beds has not yet been much explored. In the origin and manner of deposition of its ore bodies the district would seem to resemble that of Chañarcillo in Chili.

There are also veins in the granite, or associated with it, near Tombstone, which are similar to the other deposits of the territory found in this rock. The group of districts, including the Oro Blanco, Arivaca, Harshaw, etc., just north of the Mexican line, seem to possess much the same character as Tombstone. The country rock is granite, limestone, quartzite, or earlier eruptive rocks, and the ores are galena and its products of decomposition, ordinarily accompanied by copper minerals and charged with silver. They are sometimes auriferous. In the western part of the county there are gold and copper mines, with some lead ores. These are sunk on veins in granite, which carry, besides quartz, fluorite and heavy spar as gangue minerals.

PIMA.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
ARIVACA.				
Consolidated Arizona	Copper stains and black sulphurets in small quantities, with quartz and barite, (also chlorides and carbonates).	Quartz-porphyry	Quartz-porphyry	Vein.
DOS CABEZAS.				
Juniper	The ore shows blue stains, which are possibly horn-silver, (free gold and horn-silver), gangue quartz and limonite.	Shale	Shale	Vein.
Murphy	(Free gold and horn-silver), gangue quartz and limonite.	(Sedimentary)	(Slate)	Do.
HARSHAW.				
Hermosa	Kaolin and manganese oxides, (carbonates)	Quartzite	Quartzite.	
Holland	Cerussite and cupriferous minerals, (zincblende, galena, and antimonial minerals, gangue quartz, and limestone).	Limestone	Limestone	Pockets.
W. C. Davis	Cerussite, (galena, gangue quartz)	Granite *	do	Do.
HARTFORD.				
Wisconsin	Malachite, (horn-silver), gangue hematite	Limestone	Do.	
MEYERS.				
Atlanta	Galena, cerussite, copper stains, gangue quartz, fluorite, and heavy spar.	(Granite)	(Granite)	Vein.
Westward	Galena, gangue quartz	do	do	Do.
Gunsight	Galena, horn-silver, copper stains, gangue quartz, barite, and hematite.	Granite	Granite	Do.
MULE PASS.				
Copper Queen	Malachite, gangue quartz, and calcite	Slate and limestone	Slate and limestone	Vein
ORO BLANCO.				
Alaska	Malachite, (carbonates with copper and lead)	Quartz-porphyry	Quartz-porphyry	Vein.
Longarina	Galena, cerussite, malachite; possibly stephanite and horn-silver, quartz gangue.	Quartz conglomerate	Quartz conglomerate	Do.
Montana	Cerussite, gangue quartz, and limonite	Conglomerate	Utterly decomposed	Do.
North Pacific	(Gold), gangue red quartz	Granite*	Granite*	"Flat."
Warsaw	Galena, freibergite, and chalcopyrite, (carbonate near surface), gangue quartz (calc-spar).	Diorite*	Diorite*	Vein.
PIMA.				
Esperanza	Galena, pyrite, and chalcopyrite, gangue kaolinite	Probably diabase*	Probably diabase*	Vein.
San Xavier	Galena and chalcopyrite, gangue quartz	Limestone	Limestone	Connected pockets
SWISSHELM.				
Mammoth and Whale	Cerussite, gangue quartz, limonite	Limestone	Limestone	Connected pockets.
Queen	Galena and cerussite, (gangue calcareous)	do	do	Do.
TOMBSTONE				
Bradshaw	Galena, cerussite, malachite, chrysocolla, and probably mimetite, (horn-silver), gangue clay, (quartz).	Indeterminable	Indeterminable	Connected pockets.
Contention	Cerussite, (horn-silver, gangue calcite)	Probably quartz-porphyry		Do.
Emerald	Malachite, (horn-silver), gangue, quartz, and calcite	Black limestone	Black limestone	Do.
Empire	(Horn-silver), gangue quartz and limonite	Metamorphic*	Limestone	Do.
Grand Central	Minute specks of black sulphurets, (horn-silver and cerussite), gangue quartz and limonite.	Sandstone	(Sandstone)	Do.
Grand Dipper	Horn-silver, malachite, and chrysocolla, (gangue quartz and calcite).	Solfatarically - decomposed eruptive rock.		Vein.
Head Center	(Gold and horn-silver), gangue quartz and limonite	Quartzite*	Quartzite*	Do.
Mamie	Anglesite and cerussite, (horn-silver and copper stains)	do	do	Do.
Monitor	Cerussite and horn-silver, (free gold), gangue calcite, limonite, (manganese minerals).	do	do	Do.
Rattlesnake	Cerussite, (horn-silver), gangue iron oxide, (quartz and calcite).	Black limestone	Black limestone	Probably vein.
Red Top	Cerussite and horn-silver, (free gold), gangue limonite, and calcite, (quartz).	Quartzite	Quartzite	Vein.
Stonewall	(Chlorides and carbonates), gangue, pyrolusite	Limestone	Limestone	Pockets.
Sulphuret	Cerussite, (chloride and carbonate, gangue calcite)	Diabase	Diabase	Vein.
Sunset	(Chloride and carbonate), gangue, wad, (iron oxide)	Limestone	Limestone	Do.
Tioga	(Free gold and trace of silver), gangue, ferruginous quartz.	Granite	Quartzite	Do.
Toughnut Extension	(Chlorides and carbonates), gangue, ferruginous quartz.	(Porphyry for 100 feet), limestone in part siliceous.	(Porphyry for 100 feet), limestone in part siliceous.	Do.
Toughnut and Goodenough	Cerussite, (horn-silver and copper carbonate), gangue, limonite, and fluorite, (quartz and limestone).	Limestone, decomposed diorite, (and quartzite).	Limestone, decomposed diorite, (and quartzite).	Pockets.
True Blue	(Horn-silver), gangue, limonite, and pyrolusite	Diabase*	Diabase*	Vein.
TURQUOISE.				
Defiance	Galena and cerussite, (very little silver), gangue, quartz and limonite.	Limestone	Limestone	Vein.
Ajo	Chalcopyrite, bornite, and malachite, gangue fragments of rock.	Quartzite	Quartzite	Probably vein.

* Microscopically examined.

PINAL COUNTY.

Most of the mines of this county are found in the northeastern portion, near the edge of the Palæozoic. The ores are argentite and the sulphantimonide minerals, often associated with lead ores, commonly also with those of copper, and sometimes accompanied by zincblende. The gangue minerals are quartz, calcite, occasionally manganese compounds, and sometimes (in granite) heavy spar. Limestone, slate, sandstone, and quartzite, as well as granite, diabase, and diorite occur as wall rocks. Cupriferous minerals are less apt to be associated with limestones than with other metamorphic rocks or granite and diabase. The famous Silver King mine is in the Pioneer district in this county, and its great yield is a sufficient refutation of the statement sometimes made that large deposits of good ores do not occur in granite, for the country rock of this mine is a typical granite, though locally called syenite. A very great number of ore minerals occur in the Silver King, the specimens showing native silver, stephanite, freibergite, chalcopyrite, erubescite, stromeyerite, copper carbonates, galena, and zincblende. The gangue is quartz accompanied by barite. Half of the Globe district occurs in Pinal county. Its characteristics have already been mentioned under Maricopa.

PINAL.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
GLOBE.				
Golden Eagle	Galena, limonite, and malachite; quartz and pyrite gangue.	Syenite*	Syenite*	Vein.
Irene	(Carbonates, some lead, and a little arsenic), gangue, psilomelane, quartz, limonite, and chlorite.	Quartz-porphyry*	Sandstone	Do.
R. C. McCormick	Copper stains and specks which are probably stromeyerite, (chloride); gangue quartz, probably manganese.	Quartzite	Slate and limestone	Do.
Silver Era	(Sulphides and chlorides), gangue psilomelane and quartz.	Quartzite and slate	Quartzite and slate	Do.
Stonewall Jackson	Stromeyerite, gangue kaolinized rock	Diabase	Granite	Do.
PIONEER.				
Silver King	Native silver, freibergite, stephanite, zincblende, chalcopyrite, erubescite, malachite, azurite, galena, and stromeyerite, gangue quartz and barite.	Granite*	Granite*	Vein.
Surpriser	(Gold and carbonates), gangue quartz, probably manganese minerals.	Quartzite	Limestone and slate	Do.
El Capitan	Galena, polybasite, miargyrite, pyrargyrite, and chalcopyrite, (stephanite, argentite, and zincblende); gangue calcite and (quartz).	Diorite and slate	Diorite and slate	Do.

*Microscopically examined.

YAVAPAI COUNTY.

The mining districts of this county are chiefly in its southwestern portion, near the edge of the Palæozoic area. There are some gold quartz veins in granite and granite-porphyry in this county, and silver veins occur under similar conditions. It seems not improbable that the relations of these two classes of veins are the same as in Idaho, but this cannot be asserted without further information than is now available. Most of the deposits, however, are veins in metamorphic rock carrying lead and copper minerals as well as silver. Heavy spar occurs as a gangue in the Silver Belt mine, gneiss or granite forming the hanging wall.

YAVAPAI.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
BIG BUG.				
Silver Belt	Galena and cerussite, (oxides and chlorides), gangue barite and calcite.	Metamorphic	Metamorphic	Vein.
CHERRY CREEK.				
Mammoth	Gold quartz, gangue quartz, and iron	Granite	Granite	Vein.
HUMBUG.				
Tip Top	Pyrargyrite, zincblende, and pyrite, (chlorides on the upper levels), gangue quartz.	Granite	Gneiss	Vein.
PECK.				
Peck	(Carbonates and chlorides, galena and antimony, gangue quartz, iron oxide, and calcite.)	Slate	Quartzite	Vein.
Silver Prince	Galena, cerussite, and copper stains, (chlorides), gangue (country rock).	....do.....	... do	Chimneys.
TIGER.				
Tiger	Galena, zincblende, and pyrite; gangue quartz	Granite	Granite	Vein.

YUMA COUNTY.

Most of the mines of this county are near the Colorado river. They are sunk on quartz veins in highly metamorphic rocks or granite. The William Penn and other mines in the Castle Dome district are associated with a greenstone, which proves under the microscope to be diorite. The ores of Yuma county are chiefly silver ores, accompanied by lead minerals. Fluorspar and heavy spar are found in many of the veins which are inclosed in granite.

YUMA.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	WALLS.		Character of deposit.
		Foot.	Hanging.	
CASTLE DOME.				
Flora Temple	(Argentiferous galena and anglesite), gangue, (fluorspar, calc-spar, quartz, and gypsum).	Gneiss, slate, and diorite*	Gneiss, slate, and diorite*	Vein.
Galena Chief	(Ore same as above), gangue, fluorspar, and calcite.			
Norma	Galena, cerussite, and anglesite, gangue fluorspar and calcite.			
Pocahontas	Same as Norma			
William Penn	do			
SILVER.				
Princess	Galena and cerussite, (argentite and horn-silver), gangue, calcite, (quartz, fluorspar, and barite).	Granite and micaceous slate, capped with conglomerate.	Same as foot wall	Vein.
Red Cloud	Cerussite, anglesite, and horn-silver, gangue, manganese minerals, iron oxide, quartz, fluorite, barite.	Granite	Hornblende-andesite.*	
Rover	Gangue, calcite.			

* Microscopically examined.

IDAHO TERRITORY.

GENERAL CHARACTER OF THE TERRITORY.—Idaho lies in the northeastern corner of the Great Basin, directly southwest of the Bitter Root mountains. The southern portion of the territory resembles the regions farther south, its southwestern portion forming a continuation of the Nevada sage-brush deserts and the southeastern corner being the northern end of the sandy and alkaline deserts of western Utah. The upper branches of the Snake river, the sources of which are in the Yellowstone park and the Téton range, just east of the Idaho line, unite about 50 miles west of that boundary. For a short distance from the junction the course of the river is nearly south, but it bends gradually westward and northward, reaching the Oregon line on a northwest course. The area south of the Snake river is about one-fourth of the entire territory. The valley of the Snake is a plain from 50 to 100 miles in width, which is occupied by a vast sheet of recent basalt from the Wyoming line to Owyhee county. Immediately to the north of this plain, which has an elevation of a little over 4,000 feet, the character of the country changes abruptly, and most of the rest of the territory is extremely mountainous, many of the summits rising to between 10,000 and 12,000 feet above sea-level. The climate changes with the topography. Central and northern Idaho are east of Oregon and Washington territory, to the coasts of which the trade-winds of the Pacific bring an enormous amount of rain. The coast is, indeed, separated from the northern portion of the Great Basin by the Cascade range, but this is much lower and much less continuous than the Sierra Nevada to the south. The westerly winds thus bring a greater amount of moisture to northern Idaho than to Nevada, while the lofty peaks of the northern area promote its precipitation. To the north of the Snake River region Idaho is consequently well watered and well wooded, conditions of the utmost importance to profitable mining. On the other hand, the winters are long and severe, and lines of communication are extremely circuitous.

Except in the eastern counties, no portion of Idaho has been submitted to systematic geographical or geological survey, and the maps of the territory are very inaccurate. The geological information furnished by the census examination is necessarily fragmentary, presenting only data from a large number of mining localities, and but little assistance can be derived from any local publications with which I am acquainted. The following paragraphs, therefore, contain only a very rude outline of the geological conditions of the mining regions of Idaho.

A very large granite area occupies a portion of southwestern Idaho. It appears to be oval in shape, its longer diameter extending from a few miles south of Yankee fork nearly to the South Mountain district, while its shorter diameter reaches from the common boundary of Washington and Boisé counties in a southeastern direction to the Wood River country. Its total area is probably about 12,000 square miles. Not all of the country within this oval area shows granite on the surface, for Ada county is largely alluvium, and Palæozoic limestones are reported as occupying much of the more northern portions; but the extremely frequent occurrence of granite, for the most part of a single type, appears to justify the supposition that the body is continuous under the later formations.

The granite from the Idlewild mine, Carson district (Silver City), Owyhee county, is a soft gray rock with rather well developed crystals of white mica, cleavage flakes of which give the biaxial interference figure of muscovite. Slides show under the microscope that the constituents are orthoclase, oligoclase, quartz, and mica, with a little

apatite and magnetite. The quartz is extremely full of fluid inclusions, many of them containing moving bubbles. The structure is the ordinary one of granite; indeed, the rock is quite typical. In the same district occur excellent quartz-porphyries, slides of which show dihexahedral quartz crystals, with the characteristic association of glass and fluid inclusions. The association of these two rocks suggests a similar origin, or, in other words, that the granite may be eruptive, but of course proves nothing. On the other hand, there is no known evidence tending to show a derivation of the granite from sedimentary rocks. The granite from the Sub Rosa mine, in the Boisé basin, is in most respects similar to that from Carson district, though about 80 miles distant from it, but contains biotite in addition to the muscovite. In several localities in the territory the granite is extremely coarse-grained, and has even furnished marketable mica sheets.

The granite has been profoundly disturbed by eruptive action, and probably at a comparatively recent date. The evidence of this is manifold. Dikes of eruptive rock, among which the principal one appears to be basalt, (*a*) are common in the granite, and as basalt appears everywhere to be the youngest of the lavas this would indicate comparatively recent action. Hot springs, too, are thickly distributed through the granite area, in many cases issuing directly from the granite, though usually within a mile or two of known occurrences of volcanic rocks. This is most naturally accounted for by supposing that there are still remnants of volcanic heat at great depths below the surface. A further and most interesting point bearing upon the structural geology of the region and the age of the disturbances is the fact that the very numerous veins found in the granite usually strike in the direction of the ranges on the flanks of which they occur. The fissures which these veins occupy must have been formed by an upheaval such as would produce these ranges, and it seems necessarily to follow that the mountains are substantially a result of upheaval, and not of erosion. This upheaval, too, must be comparatively recent in a geological sense, say as late as the Tertiary, since otherwise the results of upheaval would have been obscured by subsequent erosion. The occurrence of the immense lava fields of the Snake River valley immediately adjoining the granite area suggests that the dynamical disturbances and the thermal action manifested in the granite may be a portion of the same series of phenomena to which the Snake river eruptions are due. The age of the veins themselves is quite another matter. The facts mentioned indicate a possibility that the ores have been deposited after the upheaval which determined the present topographical character of the country; it may be through the agency of the solfataric action (*b*) accompanying the basalt eruption. Indeed, the numerous hot springs of the granite area are in many cases highly charged with alkalies and sulphhydric acid; in short, they are solfataras. They often occur in the immediate neighborhood of the mines, one of the mining districts in the Wood River country even bearing the name of the Hot Springs district. In a mineral region solfataras, active or extinct, are usually associated with ore deposits, which are commonly ascribed to their action, and it is difficult to see how the period of solfataric activity now drawing to a close can have failed to give rise to metalliferous concentrations in Idaho.

On the other hand, the structure of the country is not incompatible with the supposition that the veins are far older than the basalt and a concomitant of a former disturbance of the granite. Fissures in the earth's crust, once formed, seem never to heal, and faults have occurred at the present day on surfaces upon which movements are known to have taken place in the Palæozoic era. The recent upheavals may merely have followed old lines of movement which had been marked by veins long before the present mountains rose. An indication tending to such a view is the fact that some veins are faulted, though this is not the rule, while slickensides, showing relative motion of the walls of the veins subsequent to the deposition of ore, are very abundant. While known movements of a more recent date than the ore deposits are thus shown, the extent of these movements usually appears to be small. Much the strongest evidence of older veins is furnished by the placers of Boisé basin and the cañon of Moore's creek, a little below and south of the basin. There is, of course, every reason to suppose that auriferous gravels are accumulations from the croppings of veins. They do not represent the whole material eroded from a country, but only the heavier portion which the streams have been unable to carry to great distances. The gravels of Boisé basin are estimated to cover 30 square miles to an average depth of about 12 feet. This large mass represents not merely a very extensive erosion of the upper country, but streams of a size inconsistent with the present rainfall of the territory. It does not follow, however, that the general character of the topography of the country must have been altered by this erosion to such an extent as to obscure the relation of the strike of the veins to the trend of the ranges. Not only were these gravels deposited when the climate was much moister, but they date from a time prior to some of the basalt eruptions, for in Moore's creek, the outlet of the Boisé basin, the gravel, which is continuous with the main deposit, is covered by a basalt cap which can scarcely be younger than the Snake River bed.

In the light of the present knowledge of the country, it seems on the whole most probable that the greater part of the quartz veins of this region are of Cretaceous or possibly Tertiary age, but it is by no means unlikely that a part of them are subsequent to the basalt, and thus are of very recent date. Should this be established by future investigations, it would afford a remarkable instance of the repetition of certain chemical and physical conditions at considerable intervals in geological history.

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a As the eruptive rocks are not immediately associated with the ore deposits in any of the mines visited, specimens of this basalt were not collected.

b See note to page 6.

A very large portion of the mines in Idaho are within the granite district, and are sunk upon veins between granite walls. These veins are very similar to those in the other granitic mining districts of the Great Basin. They are numerous and rich, but narrow, being seldom above 3 feet in thickness, though there are a few wide veins, as, for example, the Atlanta, Middle Boisé district, Alturas county, which is from 50 to 75 feet across. The gangue of the veins in the granite area is quartz, accompanied by more or less decomposed granite as horse matter. The ores carry both gold and silver in very varying proportions. The gold is either free or is mechanically entangled in pyrite, mispickel, or zincblende, while the silver appears near the surface as chloride, and at lower levels as sulphide, stephanite, tetrahedrite, or as ruby silver. Zincblende appears occasionally, and galena still more rarely. In some veins gold greatly predominates, in others silver; yet the association of minerals is the same in both classes, the relative quantities only of the two precious metals varying. There is nothing to show that the two classes of veins are of different origin or age; on the contrary, every gradation between the two extremes occurs, and sometimes both are represented in the same vein. On the Atlanta lode the Buffalo and Monarch mines produce about twice as much silver as gold, while in the Yuba tunnel, more than a mile distant from the others, but on the same lode, the value of the ore is almost wholly in gold.

From a geological point of view there is little to note concerning the variations of the ore deposits of the granitic area without going into more detail than this chapter is designed to record. On the contrary, the most striking point connected with this area is the great similarity from one end to the other of the inclosing rock and the included deposits. As soon as the water-line is passed suites of specimens from the various mines are almost indistinguishable, except in point of richness. In prospecting for these veins it would be well to observe not only the float, the character of the croppings, and the like, but also evidences of disturbance, and particularly decomposition of the country rock, for both of these phenomena are likely, though not certain, to accompany the presence of ore.

The uniformity in character of the veins throughout the granite area of Idaho, in spite of a possible difference in age and their dissimilarity to those characteristic of other formations, is highly suggestive of the nature of their origin. It is almost certain that the ores of veins are precipitated from solutions, and that these solutions acquire their valuable contents either at great depths and from unknown sources, or from the rock masses adjoining the place of deposition. The latter supposition, which is known as the lateral secretion theory, has been gaining ground of late years, and it has been proved in many cases to satisfy all the known facts. Of granite in particular Professor F. Sandberger has shown that the mica frequently carries various heavy metals, and he has pointed out an exceedingly probable series of reactions by which these metals may have been concentrated in veins. In the granite of Carson district, Owyhee county, Mr. A. Simundi has detected gold (usually amounting to at least 25 cents per ton), besides silver, even at long distances from any known deposit of ore. In view of Sandberger's investigations, it is improbable that this content is due to impregnation from veins.

If it be supposed that the Idaho veins are due to metalliferous solutions rising from great depths, it would be necessary to assume that the granite has had a chemical influence on the precipitation; for if this were due merely to reduction of temperature and pressure, the differences between the deposits in granite and those in the other rocks of the territory would be inexplicable. But the Idaho granite appears to be Archæan, and the lower surface of the Archæan has never been reached in any part of the world. Whatever may underlie it, it is certainly enormously deep. It would therefore be also necessary to assume that the granite exerted little or no precipitating influence at great depths and pressures, but only within a certain, no doubt large, distance from the surface; for were the precipitating action vigorous toward the lower portion of the granite the solutions would, for the most part, be robbed of their metallic contents at a depth of miles. If this were the case, ore veins, if reached at all, would grow richer and stronger as lower levels were attained. If any rule can be established in regard to the relations between richness and depth, it is rather that veins grow less rich and strong, though strong veins, probably as a rule, continue metalliferous to a greater depth than mining can ever be carried; but the cases in which veins grow better in proportion to the depth reached are certainly very exceptional.

On the other hand, so far as the facts concerning the veins in granite in Idaho are known, the supposition that they are the result of a leaching of the granite itself, probably by heated waters, appears simple, satisfactory, and sufficient. It would account for the difference between the veins in granite and those in other rocks by the difference in the rocks themselves, and place the source of the ores in the neighborhood of their present position. Whether any actual particle of ore originally formed a constituent of the granite on the same level or a few hundred feet below, or even above, no one would of course venture to assert. The hypothesis is merely that the rock in the neighborhood of the veins has furnished their contents.

Interesting and in part extremely important ore deposits have been discovered in the sedimentary rocks adjoining the granite area, and, indeed, on all sides of it. It has been asserted that a portion of these deposits form a continuous mineral belt. So broad a statement can hardly be indorsed, but there is sufficient evidence to warrant the assertion that the zone of country immediately surrounding the granite is well worth prospecting with unusual care, and that valuable smelting ores are not unlikely to be met with at almost any part of this zone at or near the granite contact.

The most southerly of this class of deposits are those of the South Mountain and Flint districts, in Owyhee county, near the Oregon line. The country rock is chiefly limestone, and the ore argentiferous galena. No work was done in these districts during the census year or for some time before, not, it is stated, on account of lack of ore, but in consequence of financial embarrassments arising from the failure of the Bank of California in San Francisco in 1875. To the northwest of the granite lies the Heath district, in which rich galena, high-grade copper ores, iron, and lignite are reported. No description of the country rock has been published, and as the district was idle during the census year the census examination did not include a visit to it; but the association of minerals leaves little doubt that the area is sedimentary. In the Yankee Fork district, north of the granite, the country appears to consist of gneiss (*a*) and eruptive rocks, while the ores show gold and silver, but seem to carry more copper than in the granite district. The important Custer mine is in this locality. In the Bay Horse district slates are accompanied both by milling and smelting ores, lead and copper being often prominent constituents. Both this and the preceding district were visited by Mr. Williams in the depth of winter, when work on almost all the mines was stopped, and it was impossible to obtain entirely satisfactory suites of specimens.

The Wood River country lies southeast of the granite area. Limestone, slate, and granite are the prevailing rocks, and argentiferous galena (or its products of decomposition), often extremely rich, is the chief ore. As is so usually the case with galena, the ore bodies are irregularly distributed in limestone, but the true meaning of this association has never been fully explained. Mr. Emmons, in discussing the Leadville deposits, regards the galena as precipitated by substitution for the limestone, but no one as yet has indicated the probable chemical reactions involved. Milling ores also occur in the Wood River country in the granite and slate. This region was opened up during the census year, but has since acquired great importance. The geographical distribution seems to indicate that a relation exists between these lead-bearing districts and the granitic area about which they lie. It is altogether probable that the ore was deposited throughout the whole region at the same time or times, and that the differences in the character of the ore are attributable to the different chemical and physical characters of the rocks. Were the galena deposits all on one side of the granite it might well be maintained that they were wholly independent of the gold-quartz veins in the granite, but any hypothesis which will account for them independently in their actual distribution appears extremely artificial.

Besides the deposits which have been mentioned, there are also veins carrying precious metals in Warren's camp, in the northern part of Idaho county. The ores from this camp are quartzose, carrying free gold and ores of silver. The association much resembles that met in the mines of the great granite area, and the country rock is also reported by Mr. Wolters as granite. Gold mines also occur at Iowa bar, in the extreme eastern portion of the territory. Limestone and "porphyry" are said to be the accompanying rocks. Lignite has been found in various portions of Idaho, for example, in the valley of Boisé river and on Reynold's creek, in Owyhee and Oneida counties, etc., but no commercially valuable deposits have as yet been discovered. Sulphur occurs in connection with hot springs in Bear Lake county, and deposits of alkalies exist in the same portion of the territory. Considerable quantities of float cinnabar have been found in Stanley basin, at the eastern extremity of Boisé county, and along the Salmon river between the mouth of Yankee fork and the town of Sawtooth, but not in place. Cinnabar is usually associated with Cretaceous rocks on the Pacific coast, and this fact might be of use in the search for the ore if the horizons of the neighborhood had been identified. Tinstone has been found as wash in the bed of the Jordan river, Owyhee county. This is one of the few points at which tinstone has been encountered in the far west, Temescal, San Bernardino county, California, and Deer Lodge county, Montana, being the principal other localities.

The auriferous gravels of Idaho are of great volume and extent. Though of much less importance than those of California, they have been more productive than those of any other state or territory except Montana, and have probably yielded something like thirty million dollars' worth of gold.

Three distinct classes of auriferous gravels may be recognized in Idaho. The bars of the Snake river are auriferous, but the gold is in an extreme state of division, and can be recovered at a profit only in exceptional cases. Many rich but small placers occur along the banks of the Salmon and of the other rivers of Idaho, and were either deposited by the present streams during freshets, or left by a comparatively slight shifting of the channels. Small placers have usually been found near the croppings of gold veins, which have undoubtedly furnished the auriferous gravel, and a large part of the veins, as in California, have been discovered by tracing these gravels to their sources. Most of the richest of the small placers have probably been worked out; at least few new ones of remarkable value have been discovered for many years; but enough is left to furnish occupation to a considerable population. The deep gravels of Boisé basin are of a different character. The basin is surrounded except at one point by mountains, and receives no drainage from beyond its own limits; yet it is estimated to contain some 125,000,000 cubic yards of auriferous gravel, and some of it has a depth, it is asserted, of no less than 250 feet. While there is evidence of a channel in a northeastern and southwestern direction, the gravels spread over nearly the whole basin, and occur even on the tops of considerable hills. The gravels extend several miles down Moore's creek, the outlet of the basin, and are here, in part, covered by a heavy basalt cap. The pay-dirt is

a A slide of the country rock of the Charles Dickens mine shows a structure usual in highly metamorphic rocks, corresponding to its microscopical appearance, but the constituents are so thoroughly decomposed that little more can be said of it.

commonly near the bed-rock of these beds, as is usual elsewhere. Large bowlders are frequent, as are also fossil-tree stems, which are so characteristic of the auriferous gravels of California. The Boisé basin deposits are not worked out, though their yield has decreased during the last few years, owing, it is said, rather to high wages and lack of water than to dearth of good gravel. In the earlier days of mining in Boisé basin many extremely rich bars were found, which were undoubtedly concentrations from the older gravels by modern streams. Few, if any, of these rich spots can have escaped the eager search which has been made for them. It would be impossible to account for the presence of the gravels of the Boisé basin at the head of a system of drainage without a special examination undertaken for the purpose, but it may be considered certain that a great river once flowed through the basin and transported the gravel. Some secular or paroxysmal action, not improbably a concomitant of the basalt eruption, must have modified the topography in such a way as to deflect this river, but the character of the change in the drainage is unknown. The Boisé basin gravels were probably contemporaneous with those of California; for the present rainfall, as has already been pointed out, is insufficient to account for them, and it is not probable that greatly increased precipitation can have prevailed in either of two districts so similarly situated as California and Idaho without its being shared by the other. The fossil plants also seem to be the same or extremely similar, as are also the relations to the basalt.

The following sections of gravels are selected out of a considerable number to illustrate their occurrence. The third of these is noteworthy as an exception to the ordinary rule that the pay-dirt lies near the bed-rock.

CREPISCULLA HYDRAULIC MINE.

MOORE'S CREEK DISTRICT, BOISÉ COUNTY, IDAHO (SECTION IN NORTH WORKINGS).

I	Brown soil	2–3 feet.	Maximum, 70 feet	None absolutely barren, but the bulk of the gold is thought to come from the lowest quarter of the bank.
II	Uniform low-grade gravel of medium size	47 feet.		
III	Bowlder stratum (quartz and granite)	10–20 feet.		
IV	Bed-rock granite; hard when first uncovered, slacking rapidly on exposure.			

The bank shows a fine section across the river bed 550 feet wide, which is now left at the summit of a low hill. This part of the claim is from 350 to 450 feet higher than the south workings.

R. W. SPENCER'S HYDRAULIC MINE.

BOSTON, BOISÉ COUNTY, IDAHO.

I	Loam, with some small quartz bowlders	3 feet.	Maximum, 10 feet; average, 3½ feet.	Grass-root gold. Color throughout deposit. Best pay on bed-rock.
II	Quartz, gravel, and clay, with small bowlders not over 9 inches in diameter, chiefly granite.	3 feet.		
III	Bed-rock; soft, decomposed granite.			

NOBLE, LOWER & MANN HYDRAULIC MINE.

MOORE'S CREEK DISTRICT, BOISÉ COUNTY, IDAHO.

I	Soil	2 feet.	Maximum, 30 feet; average where working, 15 feet.	Upper 3 feet from surface is the paying portion.
II	Quartz, gravel, and clay	2–6 feet.		
III	Rotten bowlders of quartz and granite, 9 inches to 4 feet in diameter	10–15 feet.		
IV	Bed-rock granite; very rough, hard when first uncovered, but slacking rapidly on exposure.			

River bed 300 feet wide and 2,000 feet long on claim. The bowlder stratum, III, is too poor to pay for working by itself, but all has to be piped off to obtain grade for race—one-fifth good pay and lower four-fifths low grade.

SUMMARY BY COUNTIES.

ADA COUNTY.—There is very little mining in Ada county, the principal industry being agriculture. The occurrence of galena not far from the granite area of the adjoining counties, however, is an interesting fact, though no work was done in the Heath district, where it occurs, in the census year.

ALTURAS COUNTY.—The western portion of Alturas county, together with Boisé county, forms a great granite district, chiefly drained by the Boisé river and its tributaries. The veins in this granite carry a quartz gangue, with gold and silver ores. In some the one metal predominates, in some the other, but as a rule both are present. The ores are free gold and auriferous pyrite, native silver, both ruby silver minerals, stephanite, freibergite, horn-silver, and galena. The gangue minerals are quartz, pyrite, chalcopyrite, mispickel, zincblende, and a little calcite. Molybdenite is also reported. Nearly all the veins dip at an angle of over 45°, and the majority strike northeast and southwest, following the trend of the mountain ranges.

To the southeast of the granite, in the Wood River country, there are deposits in limestone of galena and its decomposition products, accompanied by copper and iron minerals. Milling ores are said to have been found in the slates of this region since the expiration of the census year. There are also small placer deposits on the Salmon river and its tributaries in this county.

ALTURAS.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
BONAPARTE.				
Bonaparte Consolidated	(Gold, galena, antimony, argentiferous sulpharsenide and sulphantimonide minerals, zincblende, pyrite), quartz, and calcite.	Granite	Granite	Vein.
HARDSCRABBLE.				
Crown Point Bonanza	(Gold), quartz	(Granite)	(Granite)	Vein.
Emma	do	do	do	Do.
General Grant	Gold quartz and limonite	do	do	Do.
New Ophir	Gold quartz, pyrite, mispickel, galena, and (zincblende).	do	do	Do.
MIDDLE BOISÉ.				
Jessie Benton	Ruby silver, quartz, pyrite, chalcopyrite, (arsenical and antimonial silver ore, with auriferous pyrites).	(Granite)	(Granite)	Vein.
Buffalo	(Dark and light ruby silver, native silver, auriferous pyrites, and quartz.)	do	do	Do.
Buffalo and Atlanta	(Auriferous pyrites, argentiferous sulpharsenides and sulphantimonides, quartz, and molybdenite.)	do	do	Do.
Last Chance	Gold, auriferous pyrites, ruby silver, and quartz	do	do	Do.
Monarch	Dark ruby, horn-silver, native silver, quartz, pyrite, and probably mispickel, (light ruby, auriferous pyrites, free gold, and traces of copper).	Granite	Granite	Do.
Tahoma	Argentite, an argentiferous sulpharsenide, quartz, (ruby silver, native silver, and a little free gold).	do	do	Do.
Yuba Tunnel	(Gold), quartz, feldspar, pyrite, and mispickel.			
MINERAL HILL.				
Idahoan	Rich argentiferous galena.	(Limestone)	(Limestone).	
Jay Gould	Galena and cerussite	do	Do.	
QUEEN'S RIVER.				
Joe Daly	Free gold, quartz, mispickel, and limonite	Granite	Granite	Vein.
Mammoth	Quartz and galena, (native silver, free gold, light and dark ruby silver, and auriferous pyrites).	(Granite)	(Granite)	Do.
Silver Glance	Quartz and galena, (stephanite, native silver, light ruby silver, pyrite, and a little gold).	do	do	Do.
Washington	Quartz and galena, (free gold and base sulphides)	do	do	Do.
RED WARRIOR.				
Donnybrook Fair	Quartz colorado, (gold, pyrite, antimonial ores. No silver).	(Granite)	(Granite)	Vein.
New York	do	do	do	Do.
Wide West	do	do	do	Do.
Wildcat	Quartz and mispickel, (gold and silver in rebellious compounds).	do	do	Do.
Victor	Quartz colorado, (gold)	do	do	Do.
ROCKY BAR.				
Alturas Gold Hill	Gold, quartz, pyrite, and mispickel	Granite	Granite	Vein.
Idaho-Vishnu	Gold, galena, quartz, pyrite, and mispickel	do	do	Do.
SAWTOOTH.				
Columbia	Quartz, probably horn-silver and freibergite, (ruby silver).	(Granite)	(Granite)	Vein.
Pilgrim	Quartz and freibergite (ruby silver.)	do	do	Do.
Lucky Boy	Quartz and horn-silver	do	do	Do.

BOISÉ COUNTY.—This county is, for the most part, in the granite area mentioned under Alturas county. The veins carry chiefly gold, except in the Banner district, where the silver is in excess. The placer deposits of this county have hitherto been the most important in the country outside of California. Their character and occurrence have already been sufficiently described.

BOISÉ.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
BANNER.				
Crown Point	A sulpharsenide of lead, probably dufreynoysite, quartz and pyrite, (ruby silver, horn-silver, mispickel, sulphur, and copper compounds).	Granite diabase	Granite dike	Vein.
Panamint	Quartz, (ruby silver)	Granite	Granite	Do.
CAÑON CREEK.				
Centennial	Gold, quartz colorado	Granite	Granite	Vein.
Ebenezer	Gold quartz, iron and copper pyrites, and mispickel.	Granite	Granite	Do.
GAMBRINUS.				
Sub Rosa	Gold quartz	Granite*	Granite*	Vein.
GRANITE.				
Gold Hill	Quartz and pyrite, (gold)	Granite	Granite	Vein.
MOORE'S CREEK.				
Crepisculla Hydraulic	(Gold gravel)	Granite		Placer.
Thorn Creek Hydraulic	do	do		Do.
SHAW'S MOUNTAIN.				
North Star	Gold quartz	Granite	Granite	Vein.
Paymaster	(Gold) quartz	(Granite)	(Granite)	Do.
Rising Sun	Gold quartz, galena, copper, pyrite, and probably mispickel, (free sulphur).	Granite	Granite	Do.

* Microscopically examined.

IDAHO COUNTY.—This county appears to contain an isolated granite area in the neighborhood of Warren's camp and Florence. The quartz veins are much the same in character as those in Boisé county, and are accompanied by small deposits of auriferous gravels.

IDAHO.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
WARREN'S CAMP.				
Various mines	Gold, native silver, horn-silver, sulphurets, and quartz.	(Slate and limestone)	(Slate and limestone)	Vein.

LEMHI COUNTY.—The important mining districts of Yankee Fork, Mount Estes, and Bay Horse lie in the southern portion of this county. In the Yankee Fork district the principal rocks appear to be gneiss and an eruptive which is possibly rhyolite. (The workings were superficial, and the specimens were too much decomposed for determination.) Free gold and silver minerals are accompanied by quartz, pyrite, and copper ores. In the Bay Horse district the country rock is slate, and the ore consists of argentiferous galena, with copper minerals and traces of gold in a quartz gangue.

LEMHI.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
BAY HORSE.				
Ramshorn	(Argentiferous galena, gray copper, a little chloride and bromide of silver, copper carbonates, traces of gold, hematite and quartz.)	(Slate)	(Slate)	Vein.
YANKEE FORK.				
Charles Dickens	Iron and copper pyrites and melaconite, (gold)	Metamorphic*	Metamorphic*	Vein.
General Custer	Quartz, pyrite, and probably stephanite, (argentite).	Indeterminably decomposed yellow porphyry (locally called rhyolite).	Same as foot wall	Do.
Unknown	Same as General Custer	do	do	Do.

* Microscopically examined.

OWYHEE COUNTY.—The mining districts of Owyhee county lie about Silver City and Wagontown, on the Jordan river. This region is separated from the granite region of Alturas and Boisé counties by the Quaternary plains of Ada county, but it is extremely probable that the granite of Silver City is a portion of the larger mass to the north. To the southwest of Silver City the surface is occupied by quartz-porphyry overlying metamorphic rocks in part, and both porphyry and granite are intersected by dikes of basalt. The ores are similar to those of the northern granitic area: gold, silver, freibergite, and sulphurets in a quartz gangue. The veins follow the general trend of the mountains to the northwest and dip at high angles. As usual, small placers accompany the gold veins.

In the South Mountain district, near the Oregon line, galena occurs in limestone. Coal has been found, but only in insignificant quantities. Tinstone has been identified as float in the Jordan river.

OWYHEE.

[NOTE.—Determinations in parentheses are given on the authority of the experts.]

Mine.	Ore and gangue.	Walls.		Character of deposit.
		Foot.	Hanging.	
CARSON.				
Black Jack	Quartz, and probably argentite, (gold and horn-silver)	Metamorphic	Quartz porphyry*	Vein.
Clearbrook	Quartz, horn-silver, and probably argentite, (gold, calc-spar, copper stains).	Muscovite granite	Muscovite granite	Do.
Empire	(Free gold and argentiferous sulphurets, quartz)	(Granite)	(Granite)	Do.
Florida Hill	Gold, quartz, limonite.			
Idlewild	Quartz, horn-silver, (some gold)	(Muscovite granite)*	(Muscovite granite)*	Vein.
Owyhee	(Free gold and argentiferous sulphurets, quartz)	do	do	Do.
Potosi	Finely divided sulphurets not determinable, quartz.	Granite	Granite	Do.
Ruth	Probably argentite, quartz	Granite of somewhat gneissoid structure.	Granite of somewhat gneissoid structure.	Do.
War Eagle	(Free gold and argentiferous sulphurets, quartz)	(Granite)	(Granite)	Do.
WAGONTOWN.				
Bismarck	Gold, quartz, and limonite.	(Porphyry)	(Porphyry)	Vein.
Last Chance	Gold, quartz, and limonite	Quartz-porphyry	Quartz-porphyry	Do.
Maggie	Similar to Tremont and on same vein, not specifically determinable, quartz.	(Quartz-porphyry)	(Quartz-porphyry)	Do.
Ohio	Argentite, quartz, (gold, pyrite, and antimony)	(Porphyry)	(Porphyry)	Do.
Tremont	Stephanite, quartz, and kaolin	(Quartz-porphyry)	(Quartz-porphyry)	Do.
Webfoot	Quartz, (gold, low grade)	(Porphyry)	(Porphyry)	Do.

* Microscopically examined.

OTHER COUNTIES.

In Oneida county gold quartz veins and placers are worked at Cariboo and Iowa Bar, and along the course of the Snake river in this and Cassia counties gold washings are conducted on a small scale.

The northern counties of Kootenai, Nez Percé, Shoshone, and Washington contain gold quartz veins and placers, which are not, however, worked to any considerable extent, and the conditions of their occurrence are not known.

Salt and sulphur are obtained in Bear Lake county.

CHAPTER II.—GEOLOGICAL SKETCH OF THE ROCKY MOUNTAIN DIVISION.

BY S. F. EMMONS.

In the following pages the writer has endeavored to present a brief outline of the geological structure of the states and territories of this division as far as it bears on the ore deposits of the region, the geological occurrences of the ore deposits themselves, and their mineralogical composition as far as it has been possible to determine them. Such a sketch at the present time must, from the nature of things, be extremely unequal, and, at its best, very incomplete; but it has seemed best to give it in this incomplete form, even if it merely serves to show the gaps in our knowledge and to encourage others to fill them up. The importance of the geological relations of mineral deposits has been hitherto very much underestimated, chiefly for the reason that so few competent men have given attention to their study. For this reason geological literature contains but little trustworthy information on this subject.

The material here presented has been in part compiled from data and specimens gathered by census experts, and in part from reports of government surveys, from reports by individual geologists upon mining districts, unfortunately too few in number, and from the personal observations of the writer in portions of Wyoming and Colorado. There was difficulty in obtaining men who had at the same time a knowledge of field geology and a practical acquaintance with mines, and the limited time at the disposal of those to whom the work was intrusted rendered it practically impossible to visit every mining district. Of the specimens of ore, gangue, and country rock which it was intended should be obtained from each mine a large proportion were in a too far advanced stage of decomposition for satisfactory determination. In many cases no specimens accompanied the schedules. Hence the tables of mines, country rocks, and ores which accompany the following sections are incomplete in many important instances; but it has not been thought advisable for that reason to refrain from publishing them, even in their imperfect condition, since they contain many data useful to mining engineers, and will serve as a skeleton which may hereafter be more completely clothed as additional material is obtained. In cases where no specimens were at hand it is indicated in the table, the information given being on the authority either of the experts themselves or of some person connected with the mine. At the end of another decade it is hoped that our knowledge of these important mining regions will be such as to render it possible to present the information which is here outlined in a comparatively complete form.

The maps which accompany these sketches are intended as a guide to the reader unacquainted with the geography of the country, and will serve to show those who are already somewhat familiar with it the county divisions, which have been followed in the treatment of each section. An attempt has also been made, in a very general way, to indicate by colored dots the relative distribution among actually producing mines of ores in which gold or silver predominate. These are given, as well as the rest of the material, rather as a sketch than as a finished and accurate delineation.

GEOLOGICAL SKETCH OF COLORADO.

The state of Colorado, which is included between the 37th and 41st degrees of north latitude and the 25th and 32d degrees of longitude west from Washington, has an area of 103,645 square miles. This area may be divided into three meridional belts: a plain belt, comprising a little over one-third of the eastern portion of the state; a mountain belt, lying next west of the former, and covering also about one-third of the state; and a narrower belt on the west, which is largely a mesa country, and belongs to the so-called Colorado plateau region.

According to the classification of Lieutenant Wheeler's maps, only about one-fifteenth of the whole surface is arable land, but at the time this classification was made probably only the alluvial bottom lands of the larger streams were assumed to be available for agricultural purposes. This restriction may hold good for the mesa region, but with the late rapid increase in the population of the state increasing areas of plain country to the east of the mountains have been brought under cultivation by means of irrigating ditches, and the results obtained have shown that the soil is exceptionally favorable to agriculture, the extent to which it can be profitably carried on being probably limited only by the feasibility of irrigation. A large portion of the plain country is covered by a porous, crumbling, homogeneous soil, filling irregularities of the rock surface beneath to depths of from 5 to 20 or more feet, whose external appearance strongly resembles that of the famous loess which has proved the source of fertility of many important agricultural regions in the world.

As yet no systematic studies have been made of the geology of the plain country, and the actual extent and character of this deposit is not definitely known. It seems probable, however, that it may at least be analogous

to the loess which has been proved to exist farther east, in Nebraska and Kansas. An analysis of this soil, taken from the neighborhood of Golden, close to the foot-hills of the mountains, made in the laboratory of the United States geological survey at Denver, gave the following results:

	Per cent.
Silica	72.312
Alumina	12.664
Sesquioxide of iron	4.669
Lime	1.147
Magnesia	0.944
Potash	3.748
Soda	2.472
Water and organic matter	1.797
Phosphoric acid	0.228
	99.981

The lime and magnesia in this soil are in considerably smaller proportions than in ordinary loess soils, but at least 50 per cent. of the material may be supposed to be free quartz. It may be assumed, therefore, that at a greater distance from the mountains the proportion of silica will be smaller, and the more soluble and easily transportable salts greater. The same soil about 10 miles to the east of Denver, or 20 miles from the foot of the mountains, yielded 4.5 per cent. of lime and 0.8 per cent. of magnesia in a soluble form, probably as carbonate.

The climate of Colorado is essentially a dry one, though less so than that of New Mexico. In summer there are often showers, but they are too uncertain to be depended on for agricultural purposes.

ARTESIAN WELLS.—The extent to which agriculture may be carried on is therefore dependent mainly upon the amount of water which is available for purposes of irrigation. The various streams which emerge from the mountains yield a sufficient supply for a comparatively narrow belt along the foot-hills, but, owing to the rapid evaporation which takes place in this dry climate, they cannot be counted on for irrigating the lands at any great distance to the eastward.

Artesian wells have been suggested as another source of supply, and government aid has been called in to make practical experiments, with a view to determining whether these wells will yield water in sufficient amount for purposes of irrigation. The water supply of artesian wells is supposed to follow the laws of hydrostatic pressure; that is, where the surface water, penetrating the earth from the surface, reaches an impermeable stratum, it follows the inclination of that stratum as an underground stream. If, then, this stratum be reached by an artesian boring at a point where the surface of the ground is sufficiently below the outcrop of that stratum, the water, seeking its original level, will flow out through this boring to the surface. The structural conditions on the great plains are theoretically favorable for obtaining flowing wells. The sedimentary formations which underlie them are upturned at their western edge against the foot-hills of the mountains, and are thus accessible to the waters which drain their surface. The surface of the plains slopes regularly to the eastward, although at a very gentle angle; so that to obtain the required difference of level it will be necessary to go some distance from the mountains, as it is found in practice that the water from artesian wells does not strictly fulfill the condition of finding its own level, but that a certain portion of the difference of elevation is lost probably by friction and the want of a perfectly free underground circulation. Of the sedimentary formations the Tertiary beds lie horizontal and are not upturned, and these, owing to their porous character, probably would not carry the required supply of water. It is advisable, therefore, to avoid sinking the wells where these still exist, and fortunately their present area is probably limited. Of the Mesozoic beds, the upper formations (the Cretaceous) are largely composed of sandstones, which are also porous and more or less permeable to water. They contain also, it is true, beds of clay, but it cannot be certainly stated that these clay beds are continuous over any great areas. It is questionable, therefore, if the Cretaceous formation will yield a large supply of water, except locally, as near Denver, where a synclinal basin is formed by a slight fold in the strata to the east of it. In the Jura, below the Cretaceous, the conditions seem more favorable, as they contain a considerable amount of clay and a comparatively persistent limestone bed. The Trias is a formation largely of sandstones, and therefore not favorable, and it is only when the Carboniferous is reached, which is made up of compact and evenly-bedded limestone, that we come to strata which are beyond doubt capable of carrying the required supply of water. The thickness of these different formations has not yet been accurately determined; but it may be assumed at the foot-hills that the Cretaceous beds are at least 3,000 feet in thickness, and the Jura and Trias 2,000 more. It will be seen, therefore, that it may require a boring 5,000 feet in depth to give a permanent and considerable flow of water. On the other hand, there are good grounds for supposing that the thicknesses of the different formations decrease to the eastward, and this supposition has been in part confirmed by actual observation along a line near the southern border of the state. It is probable, therefore, that at a sufficient distance to the eastward the thickness of the beds overlying the Cretaceous formation will be very much less than the figures above given. In the present state of our knowledge these are largely matters of conjecture, and it is only by the actual experiment of boring wells that the thickness and water-bearing properties of the different formations can be determined. It is evident, however, from what has been said, that these experimental wells should be sunk near the eastern border of the state, and at points where the greatest thickness of the upper beds is likely to have

been removed, bringing the deep-seated water-carrying bed, therefore, nearest the present surfaces. To determine these points with accuracy, however, would require an accurate and systematic topographical and geological survey, which has not yet been made, and the choice of the right location must be largely a matter of chance. It seems probable, therefore, that with its exceptionally favorable conditions of climate and a soil of this character the agricultural resources of Colorado are yet but partially developed.

COAL.—Its industrial possibilities, if gauged by its natural resources in coal, the indispensable basis of almost every industrial enterprise, are almost unlimited, not less than two-thirds of the area of the state being underlaid by the coal formation. While over a great portion of this area it may lie too deep for profitable extraction, and while coal beds are by no means necessarily continuous in any particular formation over very large areas, yet the geological conditions are such that a relatively large proportion of this formation is brought to the surface and rendered available for practical working, especially along the borders of the mountain belt. Along the eastern front coal mines are already opened and working at intervals from the northern to the southern boundary of the state. Mines are also worked in the South park, in the center of the mountain belt, and in Gunnison and La Plata counties, on the western slope, while the developments in many other localities are only awaiting railroad communication and an industrial demand.

MOUNTAIN BELT.—The precious-metal production of the state is derived mainly from the mountain belt, as might have been assumed on *a priori* geological grounds, reasoning from which none would be looked for in the plain country; nor would much be expected from the mesa region, except where eruptive rocks have protruded through the sedimentary strata and formed such isolated mountain groups as the Sierra la Sal, Sierra Abajo, Sierra el Late, and others. The topography of the mountain region and the plateau country on its west, as well as its general geological structure, is pictured on the maps of the Hayden survey, of which the extreme northern strip is taken from those of the Fortieth Parallel. The most important group of rocks there represented, and intimately connected with ore deposition, viz, those of Mesozoic or Secondary age, have either entirely escaped recognition or have been classed indiscriminately as belonging either to the volcanic rocks or to granites.

The mountain belt of Colorado, which in this latitude is generally known as the Rocky mountains, to distinguish it from the other principal Cordilleran systems to the westward, the Wahsatch and the Sierra Nevada, has, taken as a whole, a due north and south trend. When examined in detail, however, it is found to be made up of a number of more or less regular chains or ridges having a general trend to the west of north, standing *en echelon* or with their ends overlapping each other, with mountain valleys of greater or less extent between them, as the result of which the structure the mountains in general seem to be divided up into two chains, with large included valleys which have received the name of "parks". The general name of Colorado, or Front, range has been given to the eastern of these divisions, and that of Park range to the western. The North, Middle, and South parks and the San Luis valley are the larger of the included valleys, the three former, with the smaller Wet Mountain valley to the south, being really a portion of the same continuous line of depression, while the valley of the Upper Arkansas stands in the same relation to the San Luis valley. The eastern front of this range presents a comparatively regular north and south line, broken here and there by bay-like valleys, running up into the mountains in a northwesterly direction and following the prevailing trend of the echelon ridges. The most important of these are the Manitou and Huerfano parks and that which extends up Oil creek from Cañon City. These in earlier geological times were actual bays in the seas in which the Palæozoic and Mesozoic rocks were deposited, while the parks were partially inclosed arms of those seas.

The western front of the mountains is, however, much more irregular, and is broken by branching mountain groups extending out, also with a general northwest trend, into the mesa country of the Colorado plateau. The principal of these outlying mountain groups, commencing on the north, are the Elk Head mountains, the White River plateau, the Elk mountains, and the San Juan mountains, in all of which, as will be seen later, there is a very great development of eruptive rocks.

GEOLOGY.—The geological history of this mountain region is, briefly and in its most general outlines, as follows: At the close of the Archæan era, or in the Cambrian ocean, a large area, covering most of what is now the Colorado range, formed a large rocky island, with a number of minor islands lying to the westward, the most important of which was that which now forms the Sawatch, from which it was more or less completely separated by the waters occupying the present depressions of the North, South, and Middle parks. During the whole of the Palæozoic and Mesozoic eras a continuous sedimentation went on in the seas surrounding these islands of material derived from their abrasion. The geological record, as far as it has been studied at the present day, gives evidence of no great disturbance during this long period, although it is probable that local elevation and subsidence might have taken place; and there is some evidence to show a general subsidence of the whole area, which gave a somewhat larger field of deposition to the later sediments of these periods. Toward the close of the Cretaceous period, at the time of the formation of the coal beds, the seas became shallower, owing to a general elevation of land, and considerable portions of the outlying areas were partially inclosed. During this time, and possibly earlier, immense masses of eruptive rock were forced up through the already deposited sediments which were still beneath the water. Unlike the lava flows of modern days, however, these molten masses were not, as a rule, spread on the surface of the rocks, but congealed before they reached it, either in large masses, in dikes, or in sheets spread out between the beds. It is impossible to say

how long before the close of the Cretaceous period the eruption of these Secondary igneous rocks commenced, but it is known that in certain localities it must have continued nearly to the close of the period. At some time after the close of the Cretaceous period a general dynamic movement took place in the Rocky mountains, by which the existing mountain ranges or islands were crushed together, broken, and elevated, and considerable areas of the adjoining sea-bed were lifted above its surface. In the general continental elevation which followed fresh-water lakes or inclosed seas were formed, in which, by the degradation of the newly-made land areas, considerable sediments were deposited. The outlines of these Tertiary seas, owing to the nature of the deposits made in them, which were easily eroded and carried away by subsequent atmospheric agencies, cannot be yet definitely determined. It can only be said that their area and location were frequently changed, and that during the Tertiary era, and subsequent to it, eruptions of igneous rock occurred, generally following the lines of earlier eruptions, but, unlike those, spreading out on the actual surface of the land, and in some cases beneath the sea. While the general form of the mountain area, as has been shown, was determined in the very earliest geological times, it is only since the Tertiary era, and in a great measure by erosion subsequent to the Glacial period, that the present sculpturing of the mountain forms and carving of the valleys have taken place. At what period during this history the different mineral deposits of Colorado were formed it is as yet impossible to say with any degree of definiteness. The gold deposits of Gilpin county in the Archæan may, like those of the Black hills of Dakota, be of pre-Cambrian age. It is probable, however, that some of these at least, and the silver deposits in the adjoining counties of Clear Creek and Boulder, were subsequent to the intrusion of the porphyries, which are presumably of later date. The silver deposits of Leadville are known to have been formed subsequent to the Carboniferous and previous to the dynamic movement at the close of the Cretaceous. Some of the silver deposits of Gunnison, on the other hand, must have been later than the Cretaceous, while those of Custer county and the San Juan region are in part at least presumably of post-Tertiary age.

ORES.—The ores of Colorado present an almost infinite variety of mineralogical composition, so that it is difficult to formulate any general laws with regard to their distribution or manner of occurrence. Of the actual precious-metal production of the state, by far the largest portion is derived from pyrites and galena and their decomposition products. The telluride ores of Boulder county and the auriferous pyrites of Gilpin county, with a few individual deposits in the southern portion of the state, constitute the source from which its gold is derived. With these exceptions its mineral deposits may be considered as essentially silver-bearing. The principal source of silver, as has already been stated, is argentiferous galena and its decomposition products, while argentiferous gray copper, or freibergite, is next to this the most important silver-bearing mineral. The sulphides of silver also occur, and in some cases bismuth is found in sufficient quantity to constitute an ore. As yet, so far as known, no copper is extracted from the ores of the state, except as an adjunct in the reduction of silver-bearing copper ores. Placer deposits are generally confined to the valley bottoms among high mountain ridges, and while they are locally of considerable value and importance, and were the original attraction which brought the mining community to the state, their present yield forms a very inconsiderable proportion of its precious-metal production. Prior to the discovery of the silver ores of Leadville mining in the state was principally confined to approximately vertical veins either in the Archæan rocks of the Front range or the eruptive rocks of the San Juan region; but since the limestone deposits of the Mosquito range have proved so exceptionally rich the attention of prospectors has been more and more turned to the ores which occur in sedimentary rocks, and many new districts have been discovered, but none to rival that of Leadville.

As regards geological distribution, gold is found in the Archæan and in the eruptive rocks of the Secondary age. In the sedimentary formations it is comparatively rare in limestone beds, but is not infrequent in siliceous beds. Silver is also found in the Archæan and in the Secondary eruptive rocks. In the sedimentary beds, on the other hand, it is more common in the limestones, although it is not exclusively confined to them. By far the greater portion of this metal produced in the state is derived from the limestones of the Palæozoic formations.

The most important generalization to be made with regard to the distribution of ore deposits is one that has been already noted in other countries, viz, that the largest and most important ore deposits are found where igneous rocks are most abundant. The experience of the writer leads him to further modify this by saying that it is the eruptive rocks of earlier age than the Tertiary volcanics with which valuable ore deposits are generally associated.

The mineral wealth of the state is by no means confined to the precious metals. Its coal beds are widespread, and contain both bituminous and anthracite coals. Gypsum beds are of frequent occurrence in the Triassic and Upper Carboniferous formations, and salt springs are not infrequent, and probably derive their supply from the same horizon. The Dakota group of the Cretaceous on the eastern foot-hills carries beds of most remarkably pure fire-clay. Excellent building-stone is quarried from the Archæan, which furnishes red granite; from the Mesozoic formations, which furnish white and red sandstones and valuable flags; and from the tufaceous rhyolite-lava beds of the plains.

EASTERN COUNTIES.

Weld, Arapahoe, Elbert, and Bent counties, and the eastern portion of Las Animas, lie entirely in the plain region east of the mountains. Their surface is covered to a depth of from 10 to 20 feet by a light, porous, almost loess-like soil, which is admirably adapted to agriculture wherever it is possible to bring water for purposes of irrigation. Where this is not possible, the natural grasses are most valuable for the raising of stock. No metallic minerals are to be looked for in this region, but it is underlaid by the rocks of the coal formation, which must contain extensive and valuable beds of this mineral, whose development is only dependent on the market demands and the depth below the surface at which it occurs.

LARIMER COUNTY.

This county includes the northern end of the Colorado range in Colorado, and, although mostly a mountain district, has as yet developed no considerable mineral wealth. One reason of this may be found in the fact that the range is here mainly made up of Archæan granite—a coarse, red, crumbling rock, which is characteristically developed at Sherman, on the Union Pacific railroad, and which has in this state thus far proved barren of metallic minerals. A further reason may be found in the comparatively limited development of Secondary eruptive rocks, which, so far as known, occur only in the western limits of the country bordering on the North park, at the head of Grand river. Mines have already been discovered near the western boundary of the county, at the head of Laramie river, in the Medicine Bow range.

GRAND COUNTY.

This county includes the North and Middle parks, whose surface is mainly covered by Mesozoic rocks, and are separated by a cross-range of eruptive porphyry and volcanics. In the Archæan mountains which inclose the county, and still more in the eruptive range which divides the two parks, the geological conditions are favorable for the formation of valuable deposits of minerals. As yet, however, owing to the difficulty of access and want of railroad connection, no important mines have been developed, and data from the few mining districts that exist within the county are entirely wanting. The coal-bearing formations originally covered the greater part of both park areas, but these have been removed in part by erosion.

ROUTT COUNTY.

This county, which extends from Grand county west to the Utah line, comprises the valleys of the Yampa and of the Little Snake rivers, which are underlaid by coal rocks, whose deposits come to the surface along the borders, but in the centers are too deeply buried beneath the overlying Tertiary beds to be practically available. These deposits, as elsewhere, afford no promise of metallic minerals. In the bordering mountains the only known mineral developments are the placer mines of Hahn's Peak district, which are found in the angle between the Archæan uplift of the Park range and the volcanic group of the Elk Head mountains. These placer deposits are evidently derived from the disintegration of Archæan rocks, and have yielded a small but constant return for many years past. Near the junction of the Elk river with the Yampa is an extremely interesting group of mineral springs carrying sulphur and free carbonic acid, known as the Steamboat springs. The coal-bearing Cretaceous formations occupy the valley of the Yampa river and a great part of the ridge which divides it from the White river on the south. Favorably situated outcrops are abundant, and only await the advent of railroads to become of practical value.

BOULDER COUNTY.

TOPOGRAPHICAL.—The mines of Boulder county are situated on the eastern slope of the Colorado or Front range, not far from the town of Boulder, which lies at the mouth of Boulder cañon where it debouches on the plains. The district containing the mines extends about 13 miles in a north and south direction, and from 4 to 10 miles from east to west.

The country is drained by a number of creeks, which cut deep cañons between the mountain spurs. These are, commencing on the north, the south branches of Saint Vrain creek, then James (popularly Jim) and Left-hand creeks, which join a little below Jamestown and flow out on the plains, as Left-hand creek, into the Saint Vrain at Longmont; next the various forks of Boulder creek (Four-mile, North Boulder, and Middle Boulder), which flow past the town of Boulder in a single stream, and also are tributary to Saint Vrain creek.

The town of Boulder is connected by the Colorado Central railroad with Denver on the south and Cheyenne on the north, and by the Boulder Valley railroad with the Denver Pacific railroad. A narrow-gauge railroad is also projected from Denver to run up into the mountains via Boulder. There are a number of small mining districts in this region whose limits were not definitely ascertained, but they are not in themselves important, except for purposes of description. The mines on the Saint Vrain are generally included in the Saint Vrain district. On

James creek is the Central district. South of Left hand creek is the Gold Hill district, with the Sunshine district nearer the foot-hills, and at the head of this creek is the Ward district. Still south of this, between Four-mile creek and North Boulder, is the Sugar-loaf district, and south of Boulder creek Magnolia district, while at the head of Middle Boulder creek is Caribou or Grand Island district.

GEOLOGICAL.—The general geological structure of the district is simple and typical of the mining districts on the eastern slope of the Colorado range. Along the foot-hills immediately adjoining the plains is a series of so-called hog-backed ridges, formed by upturned Mesozoic strata resting on the Archæan core of the range. These upturned sedimentary beds form a fringing belt, of a width varying with their angle of dip, along the entire extent of the eastern foot-hills. Just south of Boulder their angle is almost vertical, and they form a prominent peak, rising to an elevation of over 8,000 feet, or 3,000 feet above the plains. The upper member of the sedimentary series, the Laramie or Lignitic group, contains valuable coal deposits, whose outcrops, by erosion at Boulder, have been moved out some distance on the plains. Besides coal, these beds furnish admirable building-stone and flagging, and also fire-clay and lime. Of metallic minerals, however, they have as yet proved barren. The Archæan rocks immediately adjoining the plains have generally been found to contain but few valuable minerals, and it is not until the range has been penetrated for a distance of several miles that prominent deposits appear.

In Boulder county the mines are found within 2 miles of the plains. The Archæan rocks of the Boulder district consist mainly of gneiss, intersected by veins of pegmatite (or coarse-grained secondary granite) varying in width from a few inches to 40 or 50 feet. In addition to these there are later eruptive rocks of Secondary age, occurring either in dikes or massive bodies, of whose extent and character only imperfect data are obtainable. The prevailing gneiss of the region is of a type of rock not uncommon in other mining regions; and for purposes of description the name "*granite-gneiss*" has been adopted for this, for the reason that it is largely a massive rock, in which the bedding is either indistinct or not at all visible. At times this gneiss is coarsely crystalline, at others fine-grained, in which case the proportions of hornblende and biotite are relatively greater and the rock assumes a darker color. Quartz is always prominent in it. In the coarse rock two feldspars are visible, an orthoclase feldspar, generally of a delicate pink tinge, and a white opaque feldspar, which is triclinic, and frequently shows the characteristic striation on the basal cleavage faces. In a specimen from the eastern base of Sugar-loaf, examined microscopically, plagioclase feldspar is largely predominant, and is of two varieties, one probably oligoclase, the other labradorite. Magnetite, apatite, and pale zircons are sparingly present. This granite-gneiss generally forms rounded hills with extensive *débris* slopes, and presents but few prominent or angular outcrops.

The pegmatite veins, or gangues, as they are locally called, are mostly composed of white feldspar and quartz. Parts of them are coarsely granular and contain some mica, others are like a fine-grained granite, and in still others these two textures are found bearing irregular relations to each other. Sometimes they are not more than a finger thick, crossing the rock in every direction without intersecting each other, and sometimes they consist entirely of quartz. Two of these veins have strongly marked characteristics, and have been traced for a number of miles through the district. The first, the Maxwell gangue, runs a little east of north from Four-mile creek to Left-hand creek, crossing the road to Sunshine, two miles from Boulder, and is said to carry pyrites and some tellurides. The Hoosier gangue, which is supposed to form the western limit of the telluride belt, is about 30 feet in width, and runs through Gold Hill in a direction east of north. A specimen examined in this belt is like fine-grained granite in appearance, though consisting chiefly of quartz and feldspar, with black metallic particles macroscopically visible. The microscope shows only quartz, orthoclase, microcline, the remnants of biotite and titanite, and apatite in small prisms. The quartz contains fluid inclusions and hair-like microlites of rutile. This carries silver ore and gray copper. The telluride belt includes the Magnolia, Sugar-loaf, Gold Hill, and part of the Central districts. In this belt eruptive rocks are very rare, but the pegmatite veins are extremely common. West of this region are enormous masses of eruptive rock, and tellurides are not found.

In the Caribou district are rich silver ores carrying from 30 to 1,500 ounces of silver to the ton, and in the Ward district veins carrying free gold, with iron and copper pyrites, which have a general direction east and west, while the others are more nearly north and south.

Of eruptive rocks, that which forms the Sugar-loaf, a conical hill between Four-mile and Boulder creeks, is a fine-grained porphyritic rock of grayish color, showing in the hand specimen small white feldspars, biotite, hornblende, and titanite, the latter, of a yellow color, being quite frequent. Under the microscope the rock shows some augite and a crystalline groundmass containing a little quartz, but it is made up chiefly of feldspar, in rounded particles, not sufficiently well defined for their determination. A somewhat similar rock occurs on the north bank of Four-mile creek, which is more markedly porphyritic, its constituents being larger, and the large feldspar predominantly orthoclase. This rock is evidently a massive eruption of very considerable extent, as it apparently forms a much larger hill west of the Sugar-loaf and large outcrops up the north branch of Four-mile creek, nearer to the Ward district. In the saddle immediately east of the Sugar-loaf is a small dike of diabase, and about half a mile east is a larger one of the same rock, the former a dense black rock, in which only small plagioclase crystals can be distinguished, the other a granular mixture of augite, feldspar, and ore particles. Both are free from olivine. The former has a little globulitic glassy base, while the latter is entirely crystalline.

At Jamestown (also known as Jimtown) occurs a normal quartz-diorite of rather light color, although it contains considerable hornblende. Titanite is also abundant in this rock, and it forms a dike, running east and west, almost in the street of the town. The cliffs, over 500 feet in height near Jamestown, are formed of quartz-porphyry of a white color, which is partly due to alteration and partly to the absence of basic minerals. It is composed of pale flesh-colored orthoclase, sometimes having crystals one inch in diameter, with quartz, which is not particularly prominent, and occasionally a bleached mica. The ground-mass is micro-crystalline, and consists almost wholly of quartz, with a few small crystals of orthoclase and plagioclase feldspar. By its appearance it should be an older rock than any of the others. It contains 67 per cent. of silica, and by assay no gold.

A dike is found in the Ward district which contains pyrites, and is supposed to be a continuation of one of those in the Sugar-loaf district; but as no specimens were obtained, its determination could not be made. Still another dike, called the Black Eagle, south of Sugar-loaf, is said to have been traced 16 miles in an east and west direction.

MINES.—The mines of Boulder county are chiefly noted for the occurrence of telluride minerals, next to the native metals the richest and rarest ores that occur in nature.

The telluride belt occupies the eastern part of the district, extending to within a short distance of the sedimentary beds on the east. Its western limit may be roughly defined by a line running from Jamestown west of Gold Hill and through the Sugar-loaf. It comprises, as already stated, the Magnolia, Sugar-loaf, Central, and Sunshine districts. West of these it is said that no tellurides have been found. In Caribou district, where the earliest discovery was made in 1869–'70, the ores are mainly argentiferous galena, and are generally quite rich. In the Ward district, at the head of Left-hand creek, the ores are largely pyritiferous, and contain, where decomposed, free gold, but are generally difficult of reduction. In the Saint Vrain, on the other hand, where comparatively small developments have been made, there are large veins rich in copper, but contain little silver.

The district as a whole is characterized by exceptionally rich ores, in spite of which development has been very irregular and production uncertain. This is due in large part probably to the somewhat irregular manner of occurrence of the ores. The veins, which are popularly regarded as true fissure veins, and generally stand at a steep angle, are often of great width, but the rich ore, on the other hand, is concentrated in thin streaks and not very continuous bodies. If we confine the term true fissure vein to its narrowest limits, and apply it only to that form of vein which was once evidently a strong, deep-seated, open fissure that has been filled in by vein matter and ore foreign and distinct from the country rock, there are probably no true fissure veins in this district. As far as known, the vein material is almost without exception an alteration of the country rock, which is impregnated with rich mineral. This impregnation has taken place either along the contact of a porphyry body with the country rock or in a pre-existing vein of pegmatite, or again along some fault or jointing plane in the country rock itself which has been favorable to the concentration and precipitation of metallic minerals from their solutions. The direction of the veins is in general between northeast and northwest, but in Ward district an east and west direction seems to prevail. Their plane, as already stated, stands at a high angle, approaching the vertical.

Placers have been worked at various points in the narrow valleys which intersect the districts. Though rich, their superficial extent cannot be great, and no data have been gathered in regard to them.

MINERALS.—No exhaustive mineralogical study has yet been made of this interesting region. Among such rare deposits the temptation to discover new species is great, and it is necessary to accept with caution the statements as to their occurrence. In the list below the attempt has been made to give as complete as possible an enumeration of the unusual minerals occurring here under the following categories: I. Tellurides—*a*. Old species proved to occur, and cited by standard works on mineralogy; *b*. New species recognized by standard works on mineralogy; *c*. New species, probably good, but needing further investigation; *d*. Mixtures described as species. II. Other minerals mentioned which have not been confirmed by publication or analyses. The occurrence of those marked with an asterisk is doubtful either as a species or in point of occurrence, and needs further investigation.

I. Tellurides—a. Old species proved in Boulder county:

Altaite (PbTe); anal. by Genth. (Cited by Dana and Naumann-Zirkel).
Hessite (Ag_2Te); anal. by Genth.
Hessite, auriferous=petzite. Genth; not indep. sp.
Sylvanite ($AgTe_2+AuTe_2$); anal. by Genth. Cited by D. & Z.
Tellurite (TeO_2); anal. by Genth. Cited by D. & Z.
Tellurium, native, Genth. Cited by D. & Z.

b. New species recognized:

Calaverite [$M(AuTe)_2+AgTe_2$], sp. by Genth, from Calaveras co., Cal. Cited by D. & Z., sometimes regarded as a variety of sylvanite.
Coloradoite (HgTe), sp. nov. by Genth. Cited by D. & Z., orig. from Boulder co.
Schirmerite [$3(Ag_2Pb)\,S+2(Bi_2S_3)$], sp. nov. by Genth. Cited by D. Groth and Z. A mineral of the same name by Endlich, from the same locality, is pronounced a mixture. Orig. from Boulder co.

c. New species needing further investigation:

Ferro-tellurite ($FeTeO_4$), sp. nov. Genth. Mentioned by Groth. Orig. from Boulder co.

Magnolite (Hg_2TeO_4), sp. nov. by Genth. Orig. from Magnolia district; decomposition product of coloradoite mentioned by Groth.

d. Mixtures described as species:

Henryite, Endlich. Universally pronounced a mixture.

Lionite, sp. nov. by Berdell. Considered impure tellurium by Dana (App. III, p. 119).

Tellure-pyrite, J. A. Smith. Descr. by C. U. Sheppard; from description, probably a mixture.

e. Menorite (Ni_2Te_3), sp. nov. by Genth. Orig. from California. No anal. Smith authority for Boulder co.

II. Other minerals mentioned:

*Amalgam. Authority, Smith.

Argentite. Authority, Smith.

*Bismuth, native, sulphide, and carbonate. Smith.

Copper, native, minute crystals. Smith.

*Iodyrite. Endlich.

*Kobellite. Smith. Sp. not recognized in Dana.

Mercury. Smith.

*Pyrargyrite. Endlich.

Roscoelite. Sp. nov. Genth. Roscoe believes it a mixture.

CENTRAL DISTRICT.—The most prominent mine in this district is the Golden Age, near Jamestown. It is on the contact of porphyry with the Archæan, the former constituting the hanging wall. The vein is about 40 feet in width. The richest ore comes from a streak of white quartz from 1 to 2 feet thick on the foot wall, which is sometimes almost a mass of free gold. Pyrites prevail toward the hanging wall, but small rich concentrations of gold are also found at intervals.

GOLD HILL DISTRICT.—This is in the telluride belt, and is traversed by the Hoosier gangue. Many of the telluride veins cross the Hoosier gangue, and are said to be richer in its neighborhood. The most prominent among these are Cold Spring and Goldsmith Maid. The Red Cloud is the oldest mine in the district, and is the one in which tellurides were first discovered in 1872. Its vein is 3½ feet in width, and the ore was tellurides at the surface and auriferous pyrites in depth. The Slide, Melvina, and Prussian are also important deposits. The Emancipation is near the Sunshine district. All these are in the granite-gneiss, which here offers but few good exposures. The Washington Avenue mine, west of Gold Hill, carries galena, blende, and pyrites.

SUNSHINE DISTRICT.—This district comprises the easternmost development of the telluride belt. Its ores are generally of lower grade, free gold and tellurides occurring in the upper portion, passing into pyritiferous ores in depth. Prominent mines are the American, Grand View, Sunshine, Osceola, and Young America.

SUGAR LOAF DISTRICT.—In this district the Yellow Pine mine is an enrichment of the Hoosier gangue of pegmatitic granite. Other prominent mines are Baile's lode and the Emerson, both carrying telluride in granite-gneiss.

MAGNOLIA DISTRICT.—This is at present the southern limit of the telluride line. Here, as well as in the neighborhood of Jamestown, the gneissic character of the country rock is very distinct, and the bedding planes are easily distinguishable. The prevailing strike seems to be in a northeasterly direction, which is also that of most of the veins of the telluride belt. The Senator Hill is one of the most promising mines of the district. In the Keystone and Mountain Lion, which are said to be on the same vein, a narrow deposit only from 6 to 7 inches in width, the new mineral coloradoite is found.

WARD DISTRICT.—Between Gold Hill and Ward the gneiss is much contorted and the bedding very plain, and bodies of eruptive rock, which were comparatively wanting in the telluride belt, are here frequent. The most important mines are the Niwot, Columbia, and Stoughton. The ores are sulphides of iron and copper, carrying gold, and therefore, when undecomposed, difficult to reduce.

CARIBOU OR GRAND ISLAND DISTRICT is situated at an elevation of nearly 10,000 feet above sea-level. Its most important mine is the Caribou, which was discovered in 1869, and has produced a very large amount of silver ore. This is a massive mixture of galena, chalcopyrite, and zincblende, which occurs in gneiss, but closely associated with diabase. Other important mines are the No Name (which is said to cross the Caribou and fault it), the Boulder County, and Native Silver. The ores of this district are essentially silver-bearing, but also carry some gold.

Mine.	Country rock and vein.	Ore and gangue.
CENTRAL DISTRICT.		
Golden Age (near Jamestown)	Foot wall gneiss; hanging wall porphyry. Vein vertical; strike, E. and W.; dip, 44°; 40 feet wide.	Free gold, with iron and copper pyrites and quartz.
Smuggler	Mica-schist. Strike, N. and S.; dip, 60° E	Tellurides and pyrites in siliceous gangue and altered country.
GOLD HILL DISTRICT.		
American	Granite-gneiss. Strike, NE.; dip, 84° SE	Tellurides of gold, silver, and mercury, with free gold, sulphide of iron, zinc, lead, and copper; no specimens.
Cold Spring	No specimens. From the gangue it is apparently fine-grained granite, and a much-altered porphyry is near by.	Tellurides. Specimen, evidently from the side of the vein, is attrition material; clay, rounded pieces of quartz, with pyrites and tellurides.
MAGNOLIA DISTRICT.		
Keystone	Gneiss. No specimens. Vein: dip, 65°; 2 feet wide	Tellurides in quartz gangue. No specimens.
Mountain Lion	Gneiss. Vein: strike, NE.; dip, 65°; 2 feet wide	Iron oxide and free gold, with tellurides. Gangue: quartz and feldspar.
WARD DISTRICT.		
Nelson	Decomposed mica-schist. Strike, NE.; dip, 62°	Auriferous chalcopyrite and pyrite with free gold. Gangue: quartz and altered country.
Niwot	Granite-gneiss hanging wall and porphyry foot wall. Strike, E. and W.; dip, 76° N.	Massive pyrite and chalcopyrite cemented by quartz.
SUGAR-LOAF DISTRICT.		
Emerson	Altered gneiss	The same rock impregnated with fine grains of pyrite and tellurides.
Yellow Pine	Granite, with reddish feldspars and but little mica	Gray copper, azurite, malachite, and some unknown greenish mineral in a decomposed gneiss or granite.
Baile's lode	Coarse granite-gneiss with red feldspars, in which are veins of fine-grained biotite-granite.	At the contact of granites is quartz with a little galena, pyrites, and black stains.
GRAND ISLAND DISTRICT.		
Boulder County	Vein: strike, E. and W.; dip, 55° N	Galena, pyrite, and blende in quartz; blende crystals covered by a layer of hematite.
Caribou	Syenitic gneiss. Diabase occurs in the neighborhood. Vein: strike, E. and W.; dip, 14° N. (76° ?)	A massive mixture of galena, chalcopyrite, zincblende, and a mineral called "antimony".
Horsefall lode	Mica-schist. No specimen. Strike, E. and W.; dip, 85° N	Chalcopyrite and pyrite with free gold, some galena and zincblende.
Native Silver	A fine-grained biotite-granite. Near the vein the biotite has disappeared. Vein: strike, E. and W.; dip, 5° N. (85° ?)	Mixture of galena and sulphides.

JEFFERSON COUNTY.

This county includes the foot-hill region south of Boulder county as far as South Platte river and a narrow strip of the mountain region. Although mainly a mountain county, and surrounded by important mining districts, it reports no product of the metallic minerals. On the other hand, its production of coal from Ralston creek, Golden, and Morrison, and of valuable fire-clays and building-stone all along the foot-hill region, is extremely important. From the basaltic mesas at Golden a number of interesting zeolitic minerals have been obtained by Mr. Cross, of the United States geological survey, among which are analcite, apophyllite, chabazite, laumontite, mesolite, natrolite, scolecite, stilbite, and thomsonite. Jet is also found in the Tertiary beds under the lava flows and bole.

GILPIN COUNTY.

This is the smallest county in the state, and consists of a triangular bit of mountain region, covering 180 square miles of surface, drained by the north fork of Clear creek and adjoining Jefferson county on the west. It is the oldest mining region in the state, the first gold being discovered here in Russell gulch in 1859, and is still the greatest gold producer. Its placer deposits, lying along the bottoms of deep ravines, are of limited extent, but they are extremely rich, and though most of them have been worked over several times, they still yield a certain amount of gold.

This county is entirely in the Archæan formation, which consists mainly of gneiss, the prevailing type being structureless granite-gneiss, already described in the section on Boulder county. The gneiss is penetrated by various bodies of porphyry; but, owing to the peculiar readiness with which the rocks yield to atmospheric influences, few characteristic outcrops are found, so that the geological structure is not readily recognized on the surface. Here also the veins are mainly alterations of the country rock along certain planes, and rarely, if ever, show the character of a pre-existing open fissure filled by foreign material. In some cases the vein material seems to be a porphyry dike. Many of the veins have been traced to a very considerable depth, in some cases to over 1,000 feet, and it is claimed that some have been traced in length between 2,000 and 3,000 feet. The direction of the veins lies either between north and south and northeast and southwest, or within 10° of east and west. Among the more important veins the Gregory & Briggs, Bates, and a few others belong to the former, the Bobtail, Burroughs, Gunnell, and others belonging to the latter group. In all the dip is generally near the vertical. Faulting or displacement of the vein is rare, but where the vein material is porphyry it frequently contains inclosed fragments of gneissic country rock. In one mine rounded boulders of gneiss of considerable size have been found in the vein at a depth of about 700 feet from the surface, but whether their form is due to attrition of the two walls or to the rounding action of water and mineral solutions is not known.

The ores are mainly a mixture of pyrite and chalcopyrite, with less frequently galena and zincblende, carrying more or less gold. In the northern portion of the district, however, galena ores, with zincblende and pyrite, carrying silver, occur, but as a rule contain little or no gold; and similar deposits almost surround the extremely circumscribed limits of the gold-bearing area, whose radius, taking Central City as a center, is only about 1½ miles. In the gold veins the richer ore generally occurs in streaks that are not more than one foot wide, a compact fine-grained mass of pyrite, copper pyrite being as a rule richer than the ordinary pyrite. The rest of the vein, which often attains a width of many feet, carries pyrites (irregularly disseminated through a more or less decomposed mass of country rock) either in the form of white clayey material or as a mixture of quartz and feldspar. Outside the narrow streaks of solid sulphurets, the bulk of these ores, as they are extremely difficult to smelt, are generally treated by mill process, and the percentage of loss is generally much higher than in more completely oxidized ores, or those which are free from pyrites, averaging probably 40 per cent. The richer portions of the ore and concentrations of mill tailings are sent to the smelting works in the valley below. According to Mr. A. N. Rogers, of the Bobtail mine, who has had long experience in the underground workings of this district, the veins invariably follow the cleavage planes of the country rock, the planes crossing the strata with a nearly vertical dip, while the stratification of the country rock has a dip to the eastward. He also states that the porphyry has its cleavage in common with the country rock where the cleavage does not invade the veins themselves, the joints or laminæ taking the line of the veins and lying parallel with their walls. Hence he reasons that the porphyry is older than the veins, inasmuch as the cleavage is older and intersects the porphyry. These observations are of interest as giving a slight indication of the age of deposits in the Archæan, for which, as a rule, it is impossible to obtain any definite data.

The mountain region, from 12 to 15 miles in width between the mining districts and the plains, mainly included in Jefferson county, which consists also of Archæan rocks, has hitherto proved relatively barren of valuable minerals. In this region the rocks are comparatively undecomposed and the bedding planes remarkably distinct, having a prevailing easterly dip. They are generally gneissic in character, with some granite, and, as a rule, are highly siliceous.

MINERALS.—Besides the ordinary sulphides of iron, copper, zinc, and lead, sulphides and arsenides of silver are found; and among rarer minerals the occurrence of enargite (sulphide of copper and arsenic) in massive crystals in the Powers mine, in Russell district, is noteworthy. From the Wood mine, in Leavenworth gulch, a small pocket of pitchblende or uraninite was obtained by Mr. Richard Pearce, who first noticed it in the refuse of the dump. Aurichalcite is reported by Dr. Genth in connection with zinc minerals, cobellite by Dr. Loew, and melaconite by Dr. Peters with copper minerals.

The following minerals are reported from this county by J. Alden Smith and Dr. Endlich, but no analyses are given: Allophane, azurite, calamine, chalcanthite, cerargyrite, copper (native), garnet, gold (in crystals), goslarite, greenockite, jarosite, lievrite, magnesite, magnetite, magnetic pyrite, marcasite, mispickel, molybdenite, selenium, siderite, smithsonite, sulphur (native), tourmaline, willemite, wolfenite, zincite, and a variety of uranium minerals.

MINING DISTRICTS.—The mining districts, like the county, are extremely small, and their limits not definitely known. The Gregory district includes the mines in the immediate vicinity of Black Hawk and Central, the most important being the Bobtail, which is the richest and largest producer, although worked on a length of only 800 feet. On the Gregory lode claims have been located over a length of 4,500 feet, but actual explorations cover an extent much less than half of this. It is expected that these two lodes, together with the Bates (which lies to the northwest of the Gregory and nearly parallel to it), whose courses are convergent, will all unite to the southward in the Mammoth lode. Nevada district, which lies to the west of the Gregory, takes in the head of Nevada gulch, and includes the California, Kansas, Burroughs, and other lodes. The Russell district lies to the south of these, in Russell gulch. The number of mines is too great to admit of any special mention, but the following table gives the data furnished by specimens collected by the census experts:

Mine.	Country rock and remarks.	Ore and gangue.
NEVADA DISTRICT.		
American Flag	Gneiss rich in biotite	Galena, copper, and iron pyrites, and some zincblende, cemented by quartz.
California	Granite-gneiss impregnated with pyrite. A dike of quartz-porphyry 2 feet thick on the hanging wall.	Pyrite, chalcopyrite, zincblende, and galena, with siliceous cement; in some portions gray copper.
Hidden Treasure	Same walls as in the California mine	Chalcopyrite and dark blende. Gangue: altered country rock.
Jones	Fine-grained granite	Dark blende, with pyrite, and some chalcopyrite. In one case these are deposited on both sides of a thin fragment of granite-gneiss.
Kansas	Biotite-gneiss; fresh on foot wall, altered on hanging wall	Fine-grained mixture of pyrite, chalcopyrite, and fahlerz.
Bennett's Kansas	Light granite-gneiss	Fine-grained mixture of pyrite and chalcopyrite, with siliceous cement, associated with fragments of wall-rock.
Kent County	Gneiss. On the hanging wall dark blende concentrated in the fissures.	Pyrite, chalcopyrite, galena, and dark zincblende, with quartz cement.
Lacrosse (Burroughs)	Fine-grained biotite-gneiss	Pyrite, with fragments of decomposed wall-rock.
Pyrenees	Dark gneiss rich in biotite	Massive galena, with chalcopyrite and pyrite; also fragments of wall-rock cemented by blende and pyrite.
Polk County	Hanging wall fine dark mica-schist	Chalcopyrite, with some pyrite cementing fragments of gneiss.

Mine.	Country rock and remarks.	Ore and gangue.
NEVADA DISTRICT—continued.		
Sayr-Burroughs	Fine-grained gneiss	Fragments of wall-rock with a little pyrite, or massive pyrite with siliceous cement.
West Flack	Gneiss	Pyrite and chalcopyrite, with quartz.
Forks	Reddish granite	Coarse pegmatite impregnated with galena, pyrite, and chalcopyrite.
GREGORY DISTRICT.		
Bobtail	Fine-grained compact granite-gneiss, partly schistose on the foot wall.	Chalcopyrite, with some pyrite, cemented by quartz.
Cashier	Granite-gneiss impregnated with pyrite	Quartz and pyrite.
Centennial tunnel	Gneiss	Chalcopyrite and pyrite in altered country rock.
German	Gneiss	Pyrite and chalcopyrite with quartz.
Minnie	Felsite-porphyry impregnated with pyrite, and carrying fragments of Archæan rocks.	Porphyry heavily impregnated with pyrite.
Smith, Wain	Gneiss	Massive mixture of pyrite, chalcopyrite, zincblende, and galena. Gangue: altered country.
United Gregory	Amphibolite foot wall	Pyrite and chalcopyrite. Gangue: altered country.
RUSSELL DISTRICT.		
Hasceltine	Apparently gneiss	Mixture of pyrite and fluorite; galena and fahlerz occasionally present.
Powers	Gneiss	Massive enargite, with pyrite and fluorite.
Silver Dollar	Micaceous gneiss	Enargite, fahlerz, and pyrite. Gangue: feldspar and quartz.
Wyandotte	Gneiss. A porphyry dike occurs near the mine	Pyrite. Gangue: quartz and feldspar.
ENTERPRISE AND MOUNTAIN-HOUSE DISTRICT.		
Cyclops	Gneiss. Gangue? fine-grained white quartz-porphyry	Mixture of galena, blende, chalcopyrite, and occasional ruby silver. Gangue rock: white porphyry.
Fannie	Gneiss	
Toronto	Granite. Altered porphyry occurs at 70 feet distance	Decomposed granite, in which cerussite and chlorides have been deposited.
ILLINOIS CENTRAL DISTRICT.		
Egyptian	Gneiss	Pyrite, with copper and arsenical pyrites and zincblende. Gangue: quartz and feldspar.
HAWKEYE DISTRICT.		
Hard Money	Altered gneiss	Massive galena, with some cerussite and zincblende. Gangue: bleached and kaolinized country rock.
EUREKA DISTRICT.		
Gunnell	Altered gneiss	Massive chalcopyrite and pyrite. Gangue: altered country rock.
QUARTZ VALLEY DISTRICT.		
Boss	Altered and stained gneiss	Cerussite; alteration products of galena, with stains of copper. Gangue: altered country rock.

CLEAR CREEK COUNTY.

Clear Creek county lies to the south of Gilpin, and is considerably larger than the latter, having an area of 460 square miles. It extends from the western boundary of Jefferson county to the crest of the Colorado range, and is, next to Lake county, the largest producer of silver in the state. Its mines lie mainly among the steep rocky spurs between the various tributaries of the main Clear creek, but it includes also the Geneva district across the divide on the south, at the head of the Geneva creek, a tributary of the South Platte. Like Gilpin county, this county lies in the Archæan formation, the rocks being mainly gneissic, with subordinate development of granite. Porphyry dikes seem much more frequent than in Gilpin county, but this may be due in part to the steepness of the mountain slopes, on which the character of the country rock is more readily distinguished. The veins, like those of Gilpin county, seem to be mainly alterations of the country rock along a jointing or fault-plane, and are frequently in direct connection with the porphyry dikes, which form either one of the walls or constitute the vein material itself. In some cases also the vein seems to be an impregnation of a pre-existing pegmatite vein in the gneiss.

MINERALS.—The ores of Clear Creek county are essentially silver-bearing, the silver being derived from argentiferous galena, and in part from fahlores. In the eastern or lower portion of the district, where the earliest developments were made, the ores are, however, mostly pyritiferous, and contain relatively little galena, hence yield both silver and gold. In the upper districts, around Georgetown, they are mainly silver-bearing. The rich ores are smelted directly, and are generally sent out of the district for this purpose. A very considerable proportion of the product is, however, concentration ore, which is generally an impregnation of the country rock at a greater or less distance from the main crevice. This impregnation seems to take place by preference on one side of the vein, and this is generally the foot wall. These ores are concentrated, as a rule, in Georgetown, and the concentrates are sold to smelters. A relatively small proportion of the oxidized portion of the deposits, especially those which are comparatively free from lead and zinc, are suitable for milling. There is no doubt that this district contains an unusually large proportion of valuable veins; but their development has been incommensurate with the intrinsic value of the deposits for various reasons, among which are pernicious systems of working and the abundant cases

of litigation arising from the close vicinity of the veins to each other and their frequent crossings. A very large proportion of the more important mines were closed at the date of visit, and consequently the returns obtained by the expert are far from complete. Under these circumstances it were useless to attempt to form any generalizations on the direction or interdependence of the veins as a whole.

Besides the ordinary metallic sulphurets, the following minerals are reported as occurring in the county:

Anglesite, argentite, azurite, bornite, bournonite, calamine, caledonite, chrysocolla, fahlerz, garnet, minium, proustite, psilomelane, pyromorphite, silver (native), stephanite, sternbergite, stibnite, tennantite, tetrahedrite.

The following table gives the character of ore and country rock of the mines from which specimens were obtained:

Mine.	Country rock and remarks.	Ore and gangue.
BANNER DISTRICT.		
First National	Mica-gneiss; finely bedded on hanging wall; iron-stained and schistose on foot wall.	Quartz, stained reddish and yellow by iron oxide.
Big Chief	Mica-gneiss, containing on the foot wall a number of small pink garnets.	Pyrite, chalcopyrite, fahlerz, and chalcosite, with quartz matrix. Gangue: altered gneiss.
Nathan	Gneiss	Crumbling iron-stained mass with no recognizable minerals; probably altered country rock.
CASCADE DISTRICT.		
Muscovite	Hanging wall granite-gneiss; foot wall decomposed gneiss and felsite-porphyry.	Stained breccia-like mass, with no distinct metallic minerals visible.
CORRAL AND TRAIL RUN DISTRICT.		
Donaldson	Hanging wall iron-stained gneiss; foot wall grayish compact felsite.	Pyrite in quartz; smelting ore contains fahlerz; pyrite thoroughly decomposed constitutes free-gold ore. Gangue: altered gneiss.
Brooklyn	Gneiss	Pyrite and chalcopyrite with fahlerz. Gangue: quartz and feldspar.
GENEVA DISTRICT.		
Baltic	No specimen	Pyrite, chalcopyrite, blende, fahlerz, and a little galena in siliceous gangue; occasional pink calcite crystals.
GRIFFITH DISTRICT.		
Burleigh Consolidated Hercules Diamond Dunderberg Equator Junction	Gneiss, passing on one side into granite; on the other, into schists	Chiefly massive galena and chalcopyrite.
Colorado Central	Porphyry and gneiss (a)	Chalcopyrite and argentiferous galena.
IDAHO DISTRICT.		
Champion	Altered gneiss	Chalcopyrite and blende. Milling ore: altered country rock impregnated with particles of pyrite.
Gem	Indistinctly bedded gneiss	Arsenical fahlerz with azurite and malachite. Gangue: altered country rock.
Idaho tunnel	Hanging wall mainly white orthoclase; foot wall gneiss	Galena, zincblende, and pyrite deposited on hanging wall rock.
Victor	Gneiss indistinctly bedded	Zincblende, pyrite, etc., altered in high grade ore to a stained decomposed mass. Gangue: altered country rock.
IOWA DISTRICT.		
Mackey	Gneiss	Ore and gangue specimens both granite-gneiss, the gangue specimen having more visible pyrite than the pay ore.
MONTANA DISTRICT.		
Free American	No specimen	Galena, pyrite, and barite.
Murray	White granite whose mica is altered to a light greenish substance	Galena, pyrite, and chalcopyrite. Gangue: altered country rock.
Joe Reynolds	Foot wall mica-gneiss; hanging wall pegmatite vein	Galena. Gangue: quartz and feldspar.
MORRIS DISTRICT.		
Alluro	Gneiss	Pyrite, chalcopyrite with some fahlerz. Gangue: quartz and feldspar.
Alexander	Gneiss	Galena, pyrite, chalcopyrite, and possibly fahlerz. Gangue: quartz and feldspar.
Eagle	Gneiss	Seems to be mainly country rock impregnated with chalcopyrite and other minerals invisible to the eye.
SEATON DISTRICT.		
Tropic	Gneiss impregnated on foot wall with pyrites	Brilliant mass of zincblende, with galena, fahlerz, and pyrite; concentration ore wall-rock more or less impregnated with these minerals and carrying calcite.
SPANISH BAR DISTRICT.		
Fairmount-Shafter	Gneiss impregnated with pyrites more abundantly on the foot wall.	Galena, pyrite, and pyrolusite. Gangue: feldspar in large individuals.
Freeland	Gneiss varying in depth from a hornblendic variety to a feldspathic.	Fine-grained mixture of pyrite and chalcopyrite; relative richness depending on proportion of latter. Gangue: altered country rock.
Hukill	Much decomposed gneiss	Pyrite and bornite in siliceous gangue.
Mayflower	Schistose gneiss of varying character	Pyrite and galena, with some fahlerz and zincblende either massive or mixed with siliceous gangue. Gangue: altered country rock.

a Porphyry assays 0.633 to 0.063 ounce of silver per ton, with a trace of gold.

Mine.	Country rock and remarks.	Ore and gangue.
UPPER UNION DISTRICT.		
Fred Rogers Keith Pioneer	Gneiss	Chiefly massive chalcopyrite.
VIRGINIA DISTRICT.		
Lake	Gneiss	Massive galena, chalcopyrite, and pyrite, with a little fahlerz. Gangue: altered country rock.
Specie Payment	Gneiss	Rich ore, pyrite in quartz; second-class ore, gneiss impregnated with pyrites.
White Cloud	Gneiss on hanging wall	Pyrite with a little galena in quartz; low-grade ore, gneiss impregnated with pyrites.
YORK DISTRICT.		
Clifford	Gneiss. Slickensides occur	Galena and zincblende. Gangue: altered country rock.

SUMMIT COUNTY.

By the recent cession of the lands of the Ute reservation a large area of the mesa region of the Colorado plateau country between the White and Grand rivers, extending as far west as the boundary of Utah, has been added to what was originally a small mountain county. This new region, with the exception of the White River plateau, at the head of the White river, in which Palæozoic rocks, cut through and partially covered by basalts, are exposed, is mainly covered by Tertiary beds, and offers little prospect of metallic wealth.

As originally constituted, the eastern end of Summit county adjoins Clear Creek and Park counties, the crest of the Colorado range separating it from the former, and the cross range connecting this with the Mosquito range and dividing the two parks from the latter, and includes a portion of the Park range, consisting of the northern end of the Mosquito range and the Gore mountains, together with the valleys of the Blue river on the east of these mountains, and of Eagle river on the west.

The high mountain portion of the county is mainly composed of Archæan rocks, but along the valley of the Blue there are fragmentary beds of Mesozoic and Palæozoic rocks which have escaped erosion, relics of a former connection of the Mesozoic seas which filled the South and Middle parks. These rest on the Archæan of the Park range, and are repeated on its west side, the Park range probably having been lifted up by the great fault movement which is so well defined in the Mosquito range. Along the upper portion of Eagle river there are Palæozoic beds dipping north and resting on the Archæan of the northern end of the Sawatch, which, as one goes westward down the stream, gradually pass under the succeeding higher Mesozoic beds, and are finally lost under the Tertiary of the lower Grand and White rivers. Associated with the lower beds is a very considerable development of Secondary eruptive rocks, which are very inadequately represented on the existing geological maps of this region.

The lofty mountain crests which bound the county on the east have hitherto been a serious barrier to the development of its ores, which, though frequently occurring in large masses, are on the average of low grade, and cannot support heavy freight or reduction charges. The recent advent into the valley of the Blue river at Frisco of the Denver and Rio Grande road promises to ameliorate this condition of things to a limited extent; but its circuitous course, which necessitates the carrying of freight from here to Denver over five times the actual distance in a straight line, still involves relatively high freight charges on supplies and ore.

In this county there is a marked connection between the prevalence of eruptive rocks of Secondary or Mesozoic age and the richness and magnitude of the ore deposits. These are not only found in the Archæan and Palæozoic systems, but also extend up as high as the Trias. As yet none of value are known to occur in the Jurassic or Cretaceous formations.

MINING DISTRICTS.—The oldest mining districts are those in the neighborhood of Montezuma and Peru, near the head of Little Snake river, the east fork of the Blue, their veins belonging to the same mineral belt as those of Georgetown, in Clear Creek county, and of Geneva gulch and Hall valley, in Park county, from which they are respectively separated only by the intervening curving crest of the Colorado range. The deposits occur in the Archæan rocks, and consist mainly of argentiferous galena and sulphurets. Several presumably valuable mines have been developed in the district, and small smelting works have been erected, with the usual want of success attendant on small capital and a limited supply of ore. No report was furnished from this district.

Numerous ore bodies have been found at the head of the Blue river, where the Palæozoic and Triassic formations have been extensively traversed by intrusive sheets of Secondary eruptive rocks. These eruptions have undoubtedly caused considerable local metamorphism of the sedimentary beds, which have further been extensively dislocated by a complicated system of faults, so that, without a careful study in the field, it is impossible to definitely determine the geological horizon of any individual deposit. The principal developments have taken place near Breckenridge, on the northwestern slopes of mounts Hamilton and Guyot.

Reports are at hand from the Helen mine, in the Bevan district, in French gulch, whose ore body is an impregnation of quartzite, called a vein, striking NNE. and dipping 60° to the southward, and some 45 feet in width. The ore is free gold, with some silver in a quartzite, iron-stained by the leaching out of the pyrites which it originally contained.

In the McKay district the Naperville mine has a deposit of argentiferous galena and carbonates occurring between an overlying porphyry and an unreported sedimentary bed below.

The Monte Cristo mine, on the slope of Quandary peak, west of the upper valley of the Blue, is a deposit of low-grade galena, with some zincblende impregnating the Cambrian quartzite. This deposit is exceptionally favorably situated for mining, the quartzite bed in which it occurs dipping eastward at the same angle as the spur of the mountain, and the overlying white limestone and succeeding rocks above having been eroded off so that it forms the actual surface of the hill and can be quarried out. In spite of its low tenor in silver, said to average 15 ounces to the ton, it seems that under proper management the mine ought to be made to pay. Veins have been discovered at many points in the Archæan rocks that form the sharp crest of the Mosquito range, often in the most inaccessible localities; but during the census year, so far as could be discovered, none were in the condition of producing mines.

Ten-mile district, between the heads of Ten-mile creek, a fork of the Blue river, and of Eagle river, is at present the most important mining region of the county. The ores occur mainly in the Upper Carboniferous limestones and in the sandstone beds immediately above them. These lie at the western foot of the Archæan mass which forms the sharp, jagged crest of the Mosquito range, and which has been lifted up by the movement of the great Mosquito fault. An area here of some 10 miles square has been the scene of most wonderful eruptive activity during or at the close of the Mesozoic epoch. In number and size the intrusive bodies of porphyry and porphyrite which occur in these sedimentary formations, either as interbedded sheets, as dikes, or as intermediate irregularly transverse bodies, exceed even those of the neighboring region of Leadville. Between these two districts, but nearer that of Ten-mile, occurs a Tertiary eruptive mass of the rather uncommon rock nevadite, or crystalline rhyolite. Although but a portion of the probable ore-bearing area has yet been prospected, the quantity of metallic minerals found here is remarkable. Unfortunately for the prosperity of the district their quality is not so satisfactory, as they mostly run very low in silver and are extremely refractory, consisting mainly of pyrites, with a very considerable admixture of zincblende. The ore deposits mostly occur in the thin beds of limestone, which are prevalent in this formation, at or near their contact with an overlying micaceous sandstone. Less frequently they are found in actual contact with an intrusive bed of porphyry, and at other times impregnating a dike of porphyry which traverses the sedimentary formations.

The most important and the typical mine of the district is the Robinson. Its ore is an argentiferous galena of exceptionally high grade, associated with pyrites and some zincblende. It occurs at or near the surface of a bed of bluish-gray limestone, overlaid by a white micaceous limestone, dipping northward at an angle of about 17°. The ore seems to be an actual replacement of the country rock. The upper layer, locally called "white iron", which is a mixture of fine-grained crumbling pyrites with white mica, nearly free from galena, seems to be a replacement of a portion of the overlying sandstone, and is practically worthless. Below this the ore consists of a varying mixture of galena and pyrites, extending at irregular depths into the limestone, and in the larger bodies occupying nearly its whole thickness. The ore chute, whose maximum width is 100 feet, has been traced over a linear extent of 1,000 feet, following the general direction of the dip. A line of fracture, probably a fault-plane, may be observed in the roof following the line of the ore body, *i. e.*, a vertical plane at right angles to the line of strike. It seems probable that this fault-plane furnished the channel through which the ore solutions reached the limestone, inasmuch as pyrites extend apparently into the fissure as far as it has been opened, and in the portions of the limestone adjoining there is no mineral matter at its contact with the overlying sandstone at a little distance from the ore body. Small bodies of mineral have also been found in the limestone along the line of several minor fault-planes, which are also at right angles to the line of strike, and whose displacement amounts at most to a few feet. The Wheel of Fortune, on the summit of Sheep mountain, at the foot of which the Robinson mine stands, has an extremely rich body of silver ore in the same or an adjacent limestone stratum and adjoining an irregular transverse body of white porphyry.

On Elk mountain ore occurs over a very large area in a thin bed of limestone at a higher horizon than that of the Robinson. This ore is a similar mixture of pyrites and galena, oxidized near the surface, and sometimes to considerable depths along certain lines, with unaltered sulphurets on either side. This almost continuous body has been developed by the adjoining claims of the White Quail, Aftermath, Milo, Badger, Raven, Eagle, and Colonel Sellers to an extent of over 2,000 feet along the strike and 700 to 800 feet on the dip. While a great portion of this immense mass is too poor in silver to pay for working, as an instance of widely extended ore deposition it is certainly remarkable. Where the same bed crosses the north end of Sheep mountain, a mile or two to the eastward, beyond an intervening gulch, similar great bodies of pyritiferous ores, with more or less argentiferous galena, are found in the Snowbank, Nettie B., Triangle, and other mines.

Ore is found following the limestone horizons at higher levels and extending probably up into the Triassic formation. In one portion of the district, called Copper mountain, copper minerals are associated to some extent with the iron pyrites.

The Pride of the West, on Jacque mountain, is a type of the deposits which follow a narrow dike of porphyry. Here the vein mass, which is from 6 to 30 feet in thickness, crosses the formation diagonally and stands nearly vertical. It is an iron-stained quartzose mass, through which run seams or veins of barite parallel with the

walls, one being particularly persistent, and in connection with which the richest mineral is found. Where the siliceous gangue material is sufficiently unaltered it is found to be a decomposed quartz-porphyry. Another example of the type is the Little Chicago, which follows a dike of decomposed porphyry. This vein or dike yields an abundant supply of water, which is milky, from suspended particles of kaolin. Small jets of water from the adjoining rock also deposit hydrated oxide of iron, but the bodies of mineral as yet developed have been small and at widely separated intervals.

On Eagle river, in the neighborhood of Red Cliff, deposits of argentiferous galena and cerussite, associated with iron oxides, are also found in limestone, sometimes between it and an overlying white porphyry, and again with a limestone hanging wall and a quartzite foot wall. These limestone beds belong to the Palæozoic system, and are probably Carboniferous in age; but whether, like those of Ten-mile, they are in the upper portion of the Carboniferous, or, like those of Leadville, in the lower, is not known, nor is it of any practical importance. They are said to be very much broken and faulted. This district, as well as that of Ten-mile, is now reached by the Denver and Rio Grande railroad, and its ores are treated at Leadville or by some of the smelters on the plains.

PARK COUNTY.

Park county embraces the broad mountain valley of the South park, its boundary running along the crest of the Mosquito range on the west, and of the irregular chain which separates it from the Middle park on the northwest. It includes also, on the northeast, a portion of the Colorado range lying to the south of Clear Creek and to the west of Jefferson county. The valley plains are covered by sedimentary deposits of Mesozoic age, which, with underlying and conformable Palæozoic formations, slope up to the crest of the Mosquito range on the west, but are cut off abruptly against the Archæan on the east, probably by a fault. The coal beds of the Upper Cretaceous are thus included in this area, and have been extensively developed in the neighborhood of Como. Near Hamilton there are deposits of hematite iron ore, whose exact geological horizon is not known, and which have been but irregularly developed. Besides the less precious minerals, there are salt springs in the southern portion of the park, from which at one time rock-salt was obtained, and which probably originated in deposits of this mineral in the Triassic rocks. There are also indications of copper in the sandstones of the Trias, in the form, usual in these strata, of impregnations of carbonate of copper accompanying plant remains. As yet none have been discovered of economic value. Minerals carrying the precious metals have thus far been developed only in the Palæozoic formations, with their accompanying porphyries of Mesozoic age, and in the underlying Archæan.

In the northeastern corner of the county are the Hall Valley and the Geneva districts, whose deposits properly form part of the Clear Creek belt of silver-bearing ores and occur in the same gneissic formation. The Whale lode, in the latter district, is one of the most characteristic. The country rock is here a fine-grained gneiss, with a general strike of north and south and a steep dip to the west. It is intersected by numerous veins of pegmatite composed largely of feldspar. The lode itself runs northeast and southwest, dipping to the northwest at an angle of 65°, and is a thin vein, consisting mostly of barite, carrying also fluorite and quartz, with irregular bunches of galena and gray copper, and often separated from the adjoining portions of the lode by a clay gouge. This vein varies from an inch to 3 feet in thickness. The crevice of the lode is between 5 and 10 feet in width, and outside the above-mentioned vein consists of altered gneiss, more or less impregnated with pyrite, galena, zincblende, and a decomposition product. The pyrite is said to be confined to the decomposed wall-rock, and seldom occurs in the vein proper. There are numerous other veins in the vicinity of this lode which are also characterized by the occurrence of barite as gangue material. The Treasure Vault is said to have produced bismuth-silver ore.

The principal mineral developments of the county have taken place along the eastern slopes of the Mosquito range, and have been mainly derived from Palæozoic rocks, since, although numerous small deposits of gold and silver have been found in the underlying Archæan, which is exposed near the crest of the range and in the deeper cañons, and many interesting minerals have been obtained from them, no ore deposits of considerable value have yet been found in this formation.

The Palæozoic system here consists of the following series, commencing at the bottom:

	Feet.
Cambrian quartzite	200
Silurian or White limestone	200
Lower Carboniferous or Blue limestone	200
Middle Carboniferous or Weber grits	2,000 to 2,500
Upper Carboniferous, consisting of limestones, sandstones, and conglomerates	1,000 to 1,500

These formations, as well as the underlying Archæan, have been traversed by eruptive rocks of Secondary age, mainly quartz-porphyries and porphyrites, which, in the Archæan, occur generally in the form of irregular dikes, but in the Palæozoic system are mainly spread out in intrusive sheets between the beds. There is a marked connection between the prevalence of these eruptive masses and the development of mineral deposits. Indeed, in many cases here, as in the Leadville region, it is evident that the ore bodies are a concentration of the metallic minerals originally disseminated through the masses of these bodies and now deposited along their plane of contact with the sedimentary beds, and extending more or less into the mass of the latter. The type of these deposits may be found in mounts Lincoln and Bross, where most valuable and extensive ore bodies have been developed in the Moose, Russia, Hiawatha, and

other mines, which enjoy the further distinction of being the most elevated mines in the country, their altitude varying from 13,000 to 14,000 feet. The ores are mainly argentiferous galena and its products of decomposition, carbonate and sulphate of lead and chloride of silver. Barite is a frequent gangue material in the richest portion of the deposit. Pyrite also occurs with the ore, but is generally decomposed and changed to a hydrated oxide, associated with more or less oxide of manganese. These give to the mass of the ore, which frequently contains considerable mechanical admixture of clay, a red or yellow, or, where manganese predominates, a black color. The deposits occur in irregular bodies, often of great size, in the blue limestone, and generally near its upper surface. This blue limestone now forms the surface of the spurs of the mountain, sloping east at an angle of from 10° to 15°, but was originally covered by a sheet of quartz-porphyry, portions of which still remain on the highest parts of the peak. This quartz-porphyry, to which the local name of Lincoln porphyry has been given, is of a type so widespread throughout Colorado, and seems to be so intimately connected with the rich mineral deposits, that it is worthy of a detailed description. It is so thoroughly crystalline that it is often mistaken for granite. Its most striking, although not absolutely essential characteristic, is the occurrence of large porphyritic crystals of orthoclase of rather glassy appearance, with extremely well-defined faces, either in single crystals or Carlsbad twins, in size from a half inch to 2 inches in length. The ground mass is a crystalline mixture of two feldspars, in which plagioclase sometimes predominates, with mica or hornblende generally somewhat decomposed, and frequently a large amount of free quartz in double-pointed hexagonal pyramids, which often have the appearance of rounded grains. The quartz often has a pink tinge. The rock itself, taken comparatively fresh, is of greenish-gray color, but often bleached by decomposition or weathering. As to the age of the porphyry in this region, it can only be said that it is later than the Trias; but what is apparently the same rock is found in the Gunnison region, and between the North and Middle parks, breaking through the Cretaceous strata. It is, however, distinctly older than, and of a different character from, the Tertiary eruptive rocks.

The Dolly Varden mine of Mount Bross is a similar deposit of slightly different type. Its ore, which is mineralogically similar, occurs in the mass of the limestone in close proximity to a vertical dike of white quartz porphyry. The dolomitic limestone in which it occurs is the same as that in which the previously described deposits are found; and the ore has been traced to a vertical depth of over 100 feet, and in bodies extending from 40 to 50 feet on one side of the dike in the mass of the limestone. On Loveland hill, a spur next south of mounts Bross and Lincoln, are numerous deposits in the same blue dolomitic limestone, the best known of which is the Fanny Barrett, whose ore body stands vertically or at right angles to the stratification planes, and is probably deposited along a cross fissure or jointing plane.

In Buckskin gulch, between these two mountain masses, is the oldest mine of the district, the Phillips, which is an immense mass of auriferous pyrites, also carrying some silver, deposited in the beds of the Cambrian quartzite near a dike of quartz-porphyry. The Criterion mine, on the north wall of the gulch, is also in the Cambrian quartzite—an immense body of thoroughly oxidized material, whose original character cannot be determined, but which was probably a varying mixture of galena and pyrites, carrying both silver and gold. A porphyrite dike occurs near by. Colorado Springs mine, in the Red amphitheater on the southwest face of Mount Bross, is a rich deposit of galena along the bedding-planes of the white limestone. Here both diorite and quartz-porphyry are found traversing the sedimentary beds. The Sweet Home mine, near this on the cliff face, in the underlying Archæan, is principally interesting from the minerals which it has produced—combinations of silver with arsenic and antimony. From the Tanner Boy, also in the Archæan, on the opposite side of the gulch, beautiful rhombic crystals of rhodochrosite are obtained.

In Mosquito gulch, the Orphan Boy, once an important mine, is in quartzite underlying the limestone bed. The London mine, on London mountain, at the head of Mosquito gulch, has developed two strong veins of sulphurets, carrying both gold and silver, the one with a gangue of quartz, the other of calcite, which occur either in the Blue or White limestone in connection with an intrusive bed of White porphyry. These veins stand in an almost vertical position, as the beds in which they occur are turned up at a steep angle against the London fault, which crosses the formation diagonally, and by whose movement the Archæan rocks, which form the eastern half of London mountain, are brought up into juxtaposition with the Silurian and Carboniferous beds on its western point.

Southward the masses of intrusive porphyry diminish in extent, as do also the number of developed mineral deposits. Between Horseshoe and Sacramento gulches rich bodies of galena and carbonate ore, carrying silver, have been developed in the Sacramento mine, also in the Blue limestone, to the east of the London fault, from whose surface the original covering of quartz porphyry has been denuded. On the west of the London fault the Peerless and Badger mines, the former at the very crest of the range, find their ore in the same limestone which here was covered by the White or Leadville porphyry.

PLACER DEPOSITS.—The mountain masses bordering the South park on the north and west have, owing to the great elevation, been exceptionally exposed to glacial action. An enormous amount of detrital material has in consequence been accumulated in the valleys radiating out from them, which, when rearranged and concentrated, forms valuable placer deposits. The first placer gold was discovered in Tarryall creek in the fall of 1859, and placer mining has been carried on since that time with more or less vigor in the valleys of the Tarryall and of the Platte.

Near the town of Fairplay the banks of the Platte expose a thickness of over 50 feet of gravel, which has been extensively worked over by sluice mining, but is now abandoned. At present, active work is confined to the valley of the Platte opposite Alma, where hydraulic working is carried on and a gravel bed of over 60 feet in thickness on the east bank of the creek is being developed. Two important conditions for hydraulic mining on a large scale are present in the county: first, an enormous amount of gravel, and second, an abundance of water. It only remains to be practically proved whether these accumulations of gravel are sufficiently rich to pay for working.

LAKE COUNTY.

Lake county is of small area, having only 450 square miles of surface, and occupying only about 20 miles of the upper valley of the Arkansas, its boundary following the crest of the bordering ranges. Since the discovery of the Leadville mines it has become second only to Arapahoe county in population, and furnishes three-fourths of the precious-metal product of the state. Its western boundary is the Sawatch range, which is an Archæan mass in which granite predominates over gneiss, and which abounds in dikes of porphyry. The western slopes of Mosquito range on the east, and the hills on the north which form the water-shed between the Arkansas and Grand rivers, have a basis of Archæan granite and gneiss, more or less covered by remnants of the Palæozoic formations, already described in Park county, which have escaped erosion; and their lower position relative to corresponding beds on the eastern side of the Mosquito range is due in part to faulting and in part to flexure of the beds. Within these Palæozoic formations there is an enormous development of eruptive rocks, partly occurring as irregular dikes, but in the main as immense intrusive sheets, following the bedding-planes of the sedimentary rocks. Glacial erosion here, as in other elevated districts, has played an important part in the carving of the present mountain outlines, and in the flood period following the first cold maximum of the Glacial epoch a lake was formed, which occupied the head of the Arkansas valley, and was probably almost entirely included within the present boundaries of the county. The stratified gravel and sand beds which were deposited at the bottom of this lake now form terrace-like ridges bordering the present alluvial bottom of the Arkansas river. Whether the gold contents of these gravel beds, like those of California which may have had a similar origin, will be found to be, in any portion of them, sufficiently concentrated to be worked at a profit is a question which no steps have yet been taken to solve. The gravels resulting from the carving by erosion of the later-formed gulches have, however, been found to contain paying quantities of gold; and it was to the exceptional richness of those of California gulch, discovered in the spring of 1860, that the development of the enormous silver wealth of the Leadville region is indirectly due. Of late years the prominence given to silver mining has diverted attention from the gravel deposits, and their development has been practically stopped. It is probable, however, that a profitable field for hydraulic mining will be found in this county.

The mineral product of the county is mainly confined to the California mining district or the mines immediately adjoining Leadville, those of the outlying districts furnishing but a small fraction of the aggregate product. The ores are mainly argentiferous galena associated with zincblende, and, exceptionally, a little copper. They are essentially smelting ores, and their value is greatly enhanced by the fact that thus far they have been found in an oxidized condition, the lead occurring as carbonate, the silver as chloride, in a clayey or siliceous mass of hydrated oxides of iron and manganese. Here, even to a greater degree than in Park county, the main body of the ore is confined to the horizon of the Blue or Lower Carboniferous limestone, which is here invariably covered by an intrusive sheet of White or Leadville porphyry. The ore was at first supposed to be confined to the immediate contact of the limestone with the porphyry; but as developments have proceeded it has also been found to extend into the body of limestone sometimes to a depth of over 100 feet from its upper surface, and in such cases in large but very irregular deposits, as is characteristic of ore masses occurring in this rock.

Less important ore bodies, generally carrying gold rather than silver, are found at other horizons, either along bedding-planes or in gash veins crossing the stratification. Such are the Colorado Prince and Miner Boy, in the Cambrian or lower quartzite, and the Green Mountain, Tiger, and Ontario, in the Weber grits, or Middle Carboniferous. The first mine opened in the district, and the one which has produced the largest amount of gold, is the Printer Boy, which is a deposit of free gold with carbonate of lead and galena, passing in depth into auriferous copper and iron pyrites, which occurs in a body of quartz-porphyry along a vertical plane or pair of planes nearly parallel, either as cross-joints or fault-planes. The gangue material is simply a white clayey mass resulting from the decomposition of the porphyry itself, and, although at times exceptionally rich, the ore seldom shows any visible metallic minerals. The Palæozoic formations and accompanying intrusive beds of porphyry have been compressed into gentle folds and broken by a series of faults having a general north and south direction whose movement of uplift is as a rule to the east. The prevailing eruptive rock is the White or Leadville porphyry, which generally occurs above the Blue limestone, but is also in places found below it and at other horizons. Besides these there are other intrusive sheets of different varieties of quartz-porphyry, generally of extremely local development. Along the western end or lower portion of the spurs of the Mosquito range on which the mines are situated the actual surface of the ground is very largely buried to a depth of 100 feet or more beneath an accumulation of rearranged glacial or moraine material, locally called *wash*. The extremely complicated conditions resulting from this state of things renders it impracticable within the limits of the present sketch to give any detailed description of the geological structure of the district, and the reader is referred for this purpose to the memoir of the writer on "The Geology and Mining Industry of Leadville".

The most important groups of mines of the normal Leadville type, taken in the order of their development and of their relative distance from the valley, are as follows: (1.) Those of Fryer hill, which is the western extremity of a spur adjoining Evans gulch on the south, including the Chrysolite, Little Pittsburg, Little Chief, Amie, Climax, Dunkin, Matchless, and Lee mines. In these mines the ore bodies, which reach a maximum thickness of 90 feet, lie in an approximately horizontal position, and are included between two sheets of White porphyry. In some cases these ore bodies are split up by the porphyry into two or more distinct bodies. They are distinguished from the deposits in other portions of the district by the almost entire absence of the original limestone, of which they are a replacement. (2.) The mines of Carbonate hill, which adjoins California gulch on the north, include the Carbonate, Yankee Doodle, Crescent, Catalpa, Evening Star, Morning Star, Henrietta, Ætna, and Pendery. Of these the seven first-named follow the contact of the limestone and the overlying porphyry on its dip into the hill at an angle of from 15 to 25 degrees, and are east of Carbonate fault, which runs across the face of the hill, while the last two find the limestone at a lower level on the west side of the fault. (3.) To the west of Carbonate hill a second shoulder of the spur is Iron hill, which has been elevated to its relatively higher position by the movement of the Iron fault, which, like that of Carbonate hill, runs along its western base. Here the principal mines are those belonging to the Iron Silver Mining Company, which with the Smuggler, and, south of California gulch, the Rock and Dome, find their ore at or near the surface of the easterly dipping limestone, while the ore of the Silver Wave and Silver Cord, also on Iron hill, and of the La Plata, in California gulch, is mainly found in approximately vertical but extremely irregular bodies extending down into the mass of the limestone. Other important mines of this type are (4) the Florence group, on Printer Boy hill, north of Iowa gulch; (5) the Long & Derry group, on the opposite side of the gulch, and on Breece hill (6) the Highland Chief group, overlooking Evans gulch. On Yankee hill are the Andy Johnson, Chieftain, Scooper, and others. While in Stray Horse gulch the Double Decker and adjoining mines have gold ore in the lower quartzite, the Adelaide and Argentine find carbonates of lead at the contact of the White porphyry and the upper portion of the Silurian formation.

MINERALS.—The most common minerals are cerussite, anglesite, pyromorphite, and galena; chloride, chlorobromide and rarely iodide of silver; iron, generally as hydrated sesquioxide, but in the Breece iron mine as red hematite and magnetite, also in the deeper workings in the form of pyrite; manganese generally as a sort of wad, and frequently also as pyrolusite; zinc as calamine or silicate, and in depth as zincblende; bismuth as sulphide and as sulpho-carbonate in the Florence mine; vanadium as dechenite, or vanadate of lead and zinc, in the Morning Star and Evening Star mines. More rarely, native sulphur is found as a decomposition product of galena; also native gold and silver in the limestone deposits. Arsenic and antimony show themselves in the products of the smelters, the former very persistently, but are seldom found as definite minerals in the ores.

Outside the California district, the principal mine is the Homestake, on Homestake peak, in the northwestern corner of the county, which was developed before the discovery of the silver ores of Leadville. It is a rich body of argentiferous galena in Archæan gneiss, and is said to have produced at one time a considerable quantity of nickel ore in the form of an arsenical nickel mineral supposed to be gersdorffite. A number of less important mines have been developed along the western slopes of the Sawatch range in the Archæan which have produced small quantities of pyritiferous ores carrying galena. Their main value lies in the silver which they contain, which is also accompanied by a certain amount of gold. They are mostly reduced in the amalgamating mills which have been erected at Leadville for treating the few siliceous ores of the district which are free from lead. The comparative poverty of the mineral deposits of this district in gold is remarkable when one considers the exceptional richness of many of its placers. In the normal silver deposits of Leadville gold is present, if at all, in very minute quantities; so that it is not detected by the assayer, but is only found concentrated in the bullion. That it exists, however, is proved by its having been found occasionally in the state of native gold in the limestone deposits; for instance, in those of the Florence mine.

GUNNISON COUNTY.

Gunnison county lies to the west of Lake and Chaffee counties, its eastern boundary being formed by the crest of the Sawatch range. It originally included only the mountainous country connected with this range and the group of the Elk mountains which branch off from it in a northwesterly direction. Since the recent cession of the lands of the Ute Indian reservation it also includes a large portion of this reservation in the Colorado plateau region, extending to the boundary of Utah. Its present area of 11,338 square miles is greater than that of any county in the state.

The plateau region, as yet comparatively unexplored, is mainly occupied by nearly horizontal beds of Cretaceous and Tertiary age. Except, therefore, where the underlying Archæan rocks have been exposed by deep erosion, or the later formations have been traversed by masses of eruptive rock, this region affords little promise of return to the prospector in his search after deposits of the precious metals. In the eastern mountainous region, on the other hand, the geological conditions are such as to lead one to expect widespread and important deposits of metallic minerals. Owing to its isolated condition, being separated from the rest of Colorado by high mountain ranges whose lowest passes are over 10,000 feet high, and having been but recently reached by lines of railroad, but

few actually producing mines have yet been developed within its limits. In spite of the fact that it is penetrated by two lines of railroad, the Denver and Rio Grande and the Denver and South Park, its conditions would be unfavorable for the treatment of low-grade ores—the true source of wealth of a mining region—on account of the high grades which have to be overcome by these roads in reaching it, and which, therefore, enhance the cost not only of supplies, but of the movement of ore and fuel, were it not for the fact that it contains within itself the means for treating its own ores at low cost in its coal beds, which are not only exceptionally well situated for mining, but are of a quality probably superior to any on the eastern slope of the mountains. On the completion of the extension of the former road to Utah it will have an additional outlet in that direction, free from the drawback of exceptionally heavy grades.

The geology of the western slope of the Rocky mountains presents certain contrasts to that of the eastern. In the latter region, although along certain shore-lines, by unequal erosion, beds of different horizons are found abutting against the underlying Archæan, in general the lowest Cambrian beds are those which rest directly upon it. In the western region, on the other hand, erosion discloses crystalline gneisses and granites, presumably belonging to the Archæan, in direct contact with horizons as high as the Cretaceous, and at points far removed from any well-defined shore-line. The sedimentary beds also differ somewhat in lithological constitution, and are, as a rule, considerably thicker than corresponding beds on the eastern slope. Again, the coal-forming period, which on the eastern slope was at the very close of the Cretaceous (or, as some have maintained, at the commencement of the Tertiary), in the western region, to judge from the testimony of the thickness of beds overlying it, occurred considerably before the close of this epoch. The ore deposits also, which there are found mainly in the Archæan or Palæozoic formations, in the Gunnison region are found to occur also in the Mesozoic formations even as late as the uppermost portion of the Cretaceous. The bituminous coals of the Cretaceous formation, which are generally called *lignites*, but not it seems with absolute propriety, are here locally transformed into semi-bituminous and even into anthracite coals of excellent quality.

The geological structure of the Elk Mountain region is one of such extreme complexity that only the barest and most general outlines can be presented in the limited space here allotted. According to Mr. W. H. Holmes, its structure is that of a great fault-fold, *i. e.*, an anticlinal fold, running generally with the axes of the range and broken along its crest by a fault, the eastern slope of the anticlinal being relatively gentle, but the western so steep that in one portion the beds are actually inverted. Of the sedimentary beds involved in this fold only the Carboniferous, Trias, and Jura have escaped erosion in the higher portion of the mountains, while the Cretaceous beds are left along its flanks. In the center of this fold Mr. Holmes places a mass of eruptive granite. The writer has had no opportunity of verifying Mr. Holmes' observations in the center of the range, but is quite ready to accept his solution of the structural problems involved, while making a mental reservation as to the existence of eruptive granite at this point. From observations made during a hasty visit to the southern slopes of the range along Slate creek and the heads of Ohio and Anthracite creeks he is inclined to think that this eruptive body may belong, as do the eruptive masses there, to the porphyries of Mesozoic age and of the Mount Lincoln type, already described in the section on Park county. These rocks here break through the Cretaceous strata, not only in narrow and well-defined dikes, but in immense masses, forming entire mountains of most picturesque outline, of which Crested butte and Gothic peak form the simplest type, relics of nearly horizontal Cretaceous strata extending up their sides for several hundred feet above the bottoms of the present valleys. These porphyries in the region visited are indicated on the Hayden map either as eruptive granites or as Tertiary volcanic rocks. Since they break through the Cretaceous beds, they must have been erupted in post-Cretaceous times, but probably before the deposition of any distinctly Tertiary beds, and their mode of occurrence and lithological characteristics are quite different from those of Tertiary volcanic rocks. The intrusion of such enormous masses of molten material has produced an extensive and widespread metamorphism of the sedimentary beds, and may probably account for the change of the bituminous coals to anthracite.

The Elk mountains are evidently of later age than the Sawatch, and, very possibly, even later than the Mosquito or Park range. The ore deposits of the Ruby district must be of post-Cretaceous age, since they traverse Cretaceous rocks; but as to the age of deposits occurring in the older rocks no data are yet at hand. Ore has been found in almost every portion of the Elk mountains and on the flanks of the Sawatch. The principal mining centers are Aspen, on the northeast slope of the Elk mountains, and Independence, on the west slope of the Sawatch, in the drainage of Roaring Fork; Ruby, Gothic, and a number of small towns on the southwest slope of the Elk mountains; and Pitkin and Tin Cup, on the southwest slope of the Sawatch. At Independence sulphuret ores carrying silver are found in the Archæan. The Gold Cup mine, near Alpine pass, in the Tin Cup district, occurs in a black, fine-grained limestone, not unlike the Carboniferous limestones of the Mosquito range. Its ore is a silver-bearing cerussite, associated with some oxide of copper in a ferruginous and siliceous gangue. Of the ore deposits occurring in the Cretaceous rocks in Ruby district the Forest Queen mine may be taken as a type. The vein material seems to be a decomposed porphyry; probably a narrow dike traversing the Cretaceous sandstones, and standing in an approximately vertical condition. The ore is largely ruby silver and arsenical pyrite, occurring in small crevices and fissures in the decomposed porphyry. The gangue material is sometimes simply an indistinctly banded quartz.

CHAFFEE COUNTY.

Chaffee county occupies the valley of the Arkansas river between the crests of its bounding ranges from the southern boundary of Lake county down to Fremont and Saguache counties, a little below the mouth of the South Arkansas. Its mountain slopes are composed of Archæan rocks, mainly granite, traversed by porphyry dikes, with occasional remnants of Palæozoic formations in the southern parts which have escaped erosion resting on their crests. The valley bottom, as in Lake county, contains stratified beds of gravelly formation and of recent date; but whether they are of the same age as the Lake beds of Lake county, or have been formed in the Tertiary period, is not yet definitely known. The more recent gravel deposits at the mouth of the larger cañons, as well as those along the bed of the Arkansas river, yield gold. The richest are those at Cash creek, which have been worked since the earliest discovery of minerals in this portion of the country.

Its mining districts have but few developed mines, hence data with regard to them are extremely meager. In the neighborhood of the town of Granite gold-bearing veins have been worked on the east side of the valley in former years. Near Buena Vista, also on the east side, is the Free Gold district, so called from the Free Gold mine, which is an auriferous quartz vein in a syenite containing abundant titanite. The foot-wall specimen differs from that of the hanging wall, which suggests the possibility that the vein may be on a fault-plane.

The Chalk Creek district toward Alpine pass, on the opposite side of the valley, shows also syenitic country rock which contains a little quartz. The mines from which specimens were obtained are the Black Hawk, Mary Murphy, and Hortense. The vein material of the two former is a felsitic mass which may be a decomposed porphyry. In the ore specimen the only recognized minerals are pyrite and a black mineral which seems to contain manganese. The ore of the Hortense is a decomposed quartz-porphyry, from which some metallic mineral has been removed by solution.

The Monarch district is near the head of one of the branches of the South Arkansas river. The Monarch mine, from which its name is derived, is a limestone deposit, occurring between a dark-gray limestone above and a fine-grained white limestone below. The horizon of these limestones is not known, but it is very possible that they correspond to the Blue and White limestones of Leadville. The ore, like that of Leadville, is mainly cerussite or carbonate of lead. The Columbus mine, in the same district, occurs in granite, its ore consisting of fragments and crystals of quartz, cemented together by some metallic mineral colored red or yellow by oxide of iron.

DOUGLAS COUNTY.

Douglas county lies south of Arapahoe county, and extends as far as the divide between the Platte and Arkansas rivers and east of Jefferson county, including a portion of the Colorado range lying east of the Platte cañon. As is the case further north, this portion of the range is not yet found to contain valuable metallic minerals. The coal rocks, however, underlie the plain country east of the foot-hills, though as one approaches the divide they are more and more deeply buried beneath the Tertiary deposits of which this mesa-like ridge is formed. Their outcrops can be traced from the Platte cañon to the southern borders of the county, approaching nearer and nearer to the foot-hills as one proceeds southward.

In the neighborhood of Castle Rock are mesa-like ridges, which extend almost continuously to the eastward; but west of the railroad, and between it and the foot-hills, these ridges are broken by erosion into a series of isolated buttes, and are made up of gravel and coarse conglomerate derived from the Archæan formation, belonging to the Monument Creek Tertiary of the Hayden survey, whose age has not yet been determined. In the neighborhood of Castle Rock, and for some six or eight miles to the southward, the surfaces of these mesas are covered by a light pinkish-colored rhyolitic tufa, which forms an admirable building-stone, and has been very extensively used for this purpose in Denver. The outlines of this volcanic flow have not yet been accurately determined; it extends but a short distance east and west, and has an average thickness of about 20 feet.

EL PASO COUNTY.

More than half of the area of El Paso county, which lies to the south of Douglas, is plain country. Its western mountainous area includes the partially isolated mass of Pike's peak, separated from the main Front range by Ute pass and Manitou park, which once constituted a bay or arm of the Palæozoic sea.

The only mineral of industrial importance thus far developed is coal, of which working mines exist to the east of Colorado Springs. Prospectors after the precious metals on Pike's peak have, however, developed an extremely interesting series of minerals, of which those of the cryolite group may possibly prove of economic importance. The following are the species previously recognized:

Microcline, as green amazon stone and other colors; albite; biotite, var. siderophyllite; quartz, clear and smoky; fluorite; columbite; göthite; hematite and limonite as pseudomorphs after siderite; arfvedsonite; astrophyllite; zircon.

In addition to the above the following have recently been determined by the members of the Rocky Mountain division of the United States geological survey:

Topaz, phenacite, kaolinite, a peculiar green muscovite, cryolite, thomsenolite, gearksutite, and other fluorides not yet definitely determined.

FREMONT COUNTY.

Fremont county, which lies to the east of Chaffee and Saguache counties, includes the cañon valleys of the Arkansas after it bends to the eastward and a portion of the plain country beyond Cañon City. Its mountains have a base of Archæan, which in the western portion of the county is covered by Palæozoic formations, and on the north, toward the South park, by Tertiary eruptive rocks, with probably some older porphyries. Along the foot-hills at Cañon City occur the upturned Triassic and Cretaceous rocks, which furnish valuable building-stones. A limestone of the Colorado Cretaceous, which is remarkably pure, is used in making lime and as a flux for smelting works. From less pure limestone above the Triassic hydraulic cement is made. From Jurassic and Lower Cretaceous beds in the plains, as well as in the valley of Oil creek, petroleum has been obtained, and several wells, some over 1,000 feet in depth, have been sunk. As yet no considerable concentrations of oil have been developed. South of Cañon City is a synclinal basin in which the Laramie beds have escaped erosion, and where valuable coal mines have been opened by the railroad companies.

CUSTER COUNTY.

Custer county lies to the south of Fremont, and comprises the Wet Mountain valley, lying between the Wet mountains or Greenhorn range on the east and the north end of the Sangre de Cristo range on the west. The former mountains are a southern continuation *en echelon* of the Front or Colorado range, and consist of Archæan rocks, mainly granite, with Mesozoic formations resting against its eastern base. This range is relatively low, and its slopes gentle, except where cut through by deep cañons. The Sangre de Cristo range, on the other hand, which is a southern continuation, also *en echelon*, of the Mosquito or Park range, is a lofty imposing chain, whose rugged outlines suggest a very different composition. It has not been examined by the writer, but presumably consists of the same Palæozoic rocks that are found in the Mosquito range, resting on an Archæan base and traversed by Secondary eruptive rocks, of which the so-called Sangre de Cristo granite, outlined on the Hayden map, is very possibly a variety. The Wet Mountain valley at its widest point comprises a distance of over 20 miles from east to west between the crests of these bounding ridges. The valley bottom lies near the west side of this depression, its Quaternary covering resting either on the Archæan, or on the eruptive rocks which have broken through it.

The principal mines have been developed in the neighborhood of the towns of Silver Cliff and Rosita, and an area of 10 miles east and west and 6 miles north and south includes the greater portion of these. In this area the underlying Archæan is broken through and covered by Secondary eruptive rocks, among which diabase is the only type which has as yet been definitely determined. To these eruptions have succeeded flows of andesite and rhyolite, which outcrop at Rosita and Silver Cliff.

The town of Rosita is situated near the eastern end of the district, in the midst of a group of steep hills with smooth rounded slopes, which project out into the valley from the Wet Mountain range. The town of Silver Cliff, about six miles west of Rosita, is situated on the open plain near a mesa-like ridge, on whose cliff face, from which the town derives its name, are found the silver deposits of the Racine Boy mine. The rock of which this cliff is formed is a light pinkish-colored rhyolite, showing the characteristic finely laminated or fluidal structure. In the town itself, and along the eastern edge of the cliff, are outcrops of a dark pitchstone, probably a hyaline variety of the rhyolite. Outcrops of granite are found on the plains between Silver Cliff and in the hills around Rosita, rendering it probable that the rhyolite rests directly on the underlying Archæan. A number of isolated hills rise out of these plains, the most prominent of which is Round mountain, on which is situated the Plata Verde mine, and about two miles to the northward are the Blue mountains, in which is situated the Bull-Domingo mine. The bottom of the valley, through which runs Grape creek, lies still to the west of Silver Cliff, and has a considerable extent of arable land.

ORE DEPOSITS.—The ore deposits of this region are in many cases rather exceptional in character, and have given rise to considerable speculation as to their origin. As yet, however, no systematic or exhaustive study has been made of them on which to found a definite and satisfactory classification. Most prominent and remarkable are the Bassick and the Bull-Domingo, each situated near the northern limits of the eruptive rocks, the former a short distance north of Rosita, the latter 7 miles westward, correspondingly situated with regard to Silver Cliff. The characteristic feature common to these two mines is that the ore is found in large bodies without any definite boundary, forming a coating on irregularly-rounded fragments of the country rock. A favorite method of accounting for this mode of occurrence has been that the ore cavities are old craters or solfataric openings, in which the fragments of country rock have been tossed about and rounded by attrition and coated by a deposition from metallic vapors and solutions. While the known facts with regard to these deposits are insufficient to afford a positive theory with regard to their origin, the evidence is decidedly against this somewhat startling hypothesis. The country rock of the Bull-Domingo mine is a hornblendic gneiss, and therefore probably belongs to the Archæan. The ore, which is mainly an argentiferous galena, forms a regular semi-crystalline coating from one-eighth to one-quarter of an inch in thickness around the bowlders and pebbles of country rock, and fills the irregular interstices between them. These pebbles are not in direct contact one with the other, but are separated by the metallic coating belonging to each individual pebble. The galena is frequently covered by a second botryoidal

coating, probably of a siliceous nature. The deposit is from 40 to 60 feet wide, and strikes in a northwesterly direction. No fresh specimens of the country rock of the Bassick mine were obtained, and its exact nature is not therefore known. It is said to be the same on both sides of the deposit, and to be an eruptive rock. In this case it is probable that it is a breccia, and the ore is a replacement of the matrix. According to Mr. L. R. Grabill, (*a*) the deposit is an irregular opening, nearly elliptical, in horizontal sections from 20 to 100 feet in width, and standing generally vertical to the depth of present developments, *i. e.*, about 800 feet. The fragments of country rock which fill this opening vary in size from one and a half feet in diameter to the smallest dimensions. They are rarely, if ever, in actual contact with each other, while the metallic shells which surround them are tangent. The size of the fragments, as well as the quantity of ore or metallic mineral present, decreases from the center outward, without any definite limit having yet been determined. In the shell or metallic coating which surrounds these fragments Mr. Grabill distinguishes a series of concentric layers, the innermost and thinnest consisting of a mixture of sulphides of lead, antimony, and zinc, carrying about 60 ounces of silver and from 1 ounce to 3 ounces of gold to the ton. This layer is always present. A second coating, not always found, is lighter in color, and contains more lead, silver, and gold. The third shell is mainly sphalerite or zincblende, reaching a maximum thickness of 5 centimeters, which carries from 60 to 100 ounces of silver, and from 15 to 50 ounces of gold to the ton, with considerable iron, and some copper. This constitutes the principal pay-ore of the mine. The fourth coating, when present, is formed of chalcopyrite, but is much more irregular than the previous ones, and carries as high as from 50 to 100 ounces of gold and silver. Outside of these a fifth thin coating of pyrite crystals is occasionally found. All the layers have a more or less crystalline structure. The remaining interstices between the pebbles are filled with kaolin. Another singular fact connected with the deposit is the occurrence of small fragments of charcoal in cavities between the bowlders toward the outer edges of the ore body, and most commonly near the water-level. These are sometimes partially mineralized, and at others are perfectly unaltered and retain the woody structure. The greatest depth at which they have been found is 765 feet from the surface. The other minerals found in the mine are calamine, smithsonite, jamesonite, tetrahedrite, free gold, and tellurides of silver and gold in minute quantities.

Another type of deposit in the region fills more or less vertical fissures traversing the eruptive rocks which form the hill country around Rosita. The principal of these is the Humboldt-Pocahontas vein, running northwest and southeast, a short distance north of the town. The exact character of the country rock is not definitely known. This ore carries chalcopyrite and fahlerz, with a little siderite, in a gangue of barite.

The Pacine Boy mine, near Silver Cliff, forms a third distinctive type, and seems to be an irregular impregnation of the country rock, the ore in general showing a little black staining of some manganese mineral as its only visible metallic constituent. Thin films of chloride of silver are sometimes distinguishable. This is a free-milling ore of comparatively low grade, but valuable on account of its great mass. Plata Verde mine has not been worked since its mill was finished, and no data are available in regard to the character of its deposit, which is, however, in rhyolitic rock. The ore is chloride of silver, with some sulphurets, impregnating the country rock. The Terrible mine, in the Archæan, is about 12 miles northeast of Silver Cliff, and has a foot wall of fine-grained iron-stained gneiss. The vein strikes N. 20° W., and dips 78° NE. Its ore consists of a massive cerussite, sometimes cementing fragments of wall rock, the gangue material being decomposed country rock. The Gem, a newly-opened mine some 12 miles north of this district, is interesting as having afforded specimens of a rich nickel ore. On Grape creek, in the northern portion of the county, a considerable body of titaniferous magnetite has also been discovered. Both these last-named deposits are probably in the Archæan.

Ore deposits have also been developed on the east slope of the Sangre de Cristo range about 7 miles west of Silver Cliff. The Verde mine has a vein striking N. 50° W., and dipping 60° SW., said to be in granite. Its ore is a mixture of pyrite and chalcopyrite, with fahlerz.

HUERFANO COUNTY.

Huerfano county, lying south of Custer and Pueblo, is largely a plain country, and only its eastern end, which includes Huerfano park, a southern continuation of the Wet Mountain valley, extends into the mountain region. The surface of the plain country, as well as the bottom lands of Huerfano park, which was a bay in the original Archæan shore-line, is covered by Cretaceous deposits; and it is only along the crests of the bounding ridges, the Wet mountain and the Sangre de Cristo, and near the eruptive mass of the Spanish peaks, that the rocks liable to carry metallic minerals are exposed.

The schedule reports furnish data from only a single mine, the Mountain Monarch, in the Third Judicial district. This mine is situated on the north slope of the West Spanish peaks, about 10 miles south of La Veta. Its deposit is said to be a fissure vein running east and west, with a shallow dip south, and is from 3 to 6 feet wide. The ore is a banded vein material, consisting of galena, pyrite, chalcopyrite, and fahlerz. The country rock is said to be granite, and the gangue material porphyry. No specimens of either were sent in, but it seems probable to the writer that both belong to the crystalline quartz-porphyries, whose mode of occurrence has been already described, and which correspond with what is known of the eruptive mass of the Spanish peaks.

a Trans. A. I. M. E., August, 1883.

THE SAN JUAN REGION.

GEOLOGY.—The San Juan mining region, which embraces San Juan county, with the adjoining counties of Hinsdale, Ouray, La Plata, and portions of Rio Grande and Conejos counties, takes its name from the San Juan mountains, a lofty and irregular mass, which, like the Elk mountains, have a general northwest trend, but are of still more irregular structure, and have an even greater predominance of eruptive rocks. Owing to the prevalence of the latter, which constitute the mass of a great portion of the mountain region, the structure of the sedimentary beds is necessarily very indistinct, and the geological data which are obtainable are of the most unsatisfactory nature. The eruptive rocks occur in great masses, sections 2,000 and 3,000 feet thick being shown in the different cañons, their most characteristic and striking feature being the occurrence of immense breccia beds over wide areas throughout the region. The entire mass of these rocks has been classed by the members of the Hayden survey among the Tertiary eruptives, and they have been colored on the map as either trachytes or basalts. While basalts undoubtedly do occur, and trachytes may be found, these or later flows cover bodies of earlier eruptive rocks, and it seems probable to the writer that the deposits in the region will be found to occur mainly in the latter. This idea is supported by the examination of the specimens of the country rock brought in by census experts. Although these specimens were mainly in a condition of alteration so far advanced—as is common among eruptive rocks in the neighborhood of mines—that their original condition could rarely be definitely determined, some undoubted porphyries, diorites, and diabases occur among them, and the others can be referred, with more or less probability, to varieties of one of these types, while among the eighteen specimens which were examined microscopically only a single undoubted Tertiary rock (basalt) was found. This occurs as the foot wall of the Ohio Consolidated mine, in Hinsdale county. In some of the valleys erosion has exposed granite and gneiss, presumably of Archæan age, underlying these eruptives. At the head of the Uncompahgre river, near Ouray, beds of Palæozoic and Lower Mesozoic age are found resting on the granite and sinking to the northwest under the Cretaceous formations. The latter cover the western portions of the counties of Ouray and La Plata, which, like those of Gunnison and Grand counties, belong to the Colorado plateau region. On the southern slopes of the San Juan mountains, in San Juan county and the northeastern corner of La Plata county, there is exposed a considerable area of Palæozoic rocks, which to the southward pass under the Cretaceous formations of the valley of the San Juan. A large portion of these are of undoubted Carboniferous age, but adjoining the valley of the Animas, on the east, is a mountainous region called the Quartzite peaks, composed of rocks whose age is a matter of considerable uncertainty. The limestones which adjoin the quartzite have been considered by Dr. Endlich as Devonian mainly on the evidence of a single well-defined fossil. This fossil is, however, pronounced by Professor R. P. Whitfield to be a Carboniferous and not a Devonian type. The quartzite formations, which are supposed to underlie these, are called on the map Metamorphic-Palæozoic, the rubric of this formation, however, being included in the Archæan; a seeming contradiction of terms of which the writer has found no explanation. It is probable that the Palæozoic formations thicken to the southward, as they are known to do to the westward; and since the Devonian is well developed in Utah and Nevada, and fossils of the Waverly type have recently been found in Lake valley, New Mexico, it is very possible that this formation may be represented in the region, but its existence cannot yet be considered as determined.

ORE DEPOSITS.—The most striking feature in the mineral development of the San Juan region is the immense quartz veins traversing the eruptive rocks, which stand nearly vertical, their outcrops projecting like walls from the surface, and often traceable to a depth of several thousand feet along the sides of the deep valleys and cañons. According to Mr. R. C. Hills, these veins cross both the older eruptive rocks and what he considers as the overlying Tertiary eruptives; but it is only in rare instances that the latter have been shown to inclose valuable ore bodies, these being found generally in the older massive or brecciated rocks, whose prevailing color is some shade of green. Veins are also found in the underlying gneiss and granite; and in the western portion, especially in the neighborhood of Rico, are deposits in limestones of Carboniferous age, frequently along bedding-planes and at the contact with sheets of intrusive igneous rocks.

The deposits of the region are mainly argentiferous. In some, however, gold is the chief pay mineral; in others both gold and silver occur. Free-milling gold ores are, as a rule, comparatively rare, the majority of the ores containing a large admixture of base metals, so that they require smelting. The prevailing minerals are argentiferous galena, gray copper, generally argentiferous or freibergite, and, in the upper part of the deposits, native silver and pyrargyrite or ruby silver. Bismuth-silver minerals are found in several mines in considerable quantities. Gold is apparently derived in most part from pyrite. Barite is not uncommon as a gangue material, and fluorite also occurs, although more rarely. Compounds of antimony and tellurium are said to occur, and rarely molybdenite and some nickel minerals. The veins are said to have a banded structure, and the quartz is said to be crystalline. It must be noted, however, at the same time, that in many cases one or both walls are not well defined, and a portion at least of the vein material is quite frequently decomposed country rock. Of the age of these deposits, in the uncertainty which exists as regards the true character of the various country rocks, but little can be definitely said. Mr. Hills, who has devoted considerable study to ore deposits, especially those of Ouray county, divides the veins into three systems, which he regards as distinct and probably of different age: First, silver-bearing veins, standing at high angles (80° to 90°) and thin (6 inches to 3 feet wide), with no gouge or

selvage, carrying essentially base-metal ores. Second, gold-bearing veins, large and strong, dip about 60°, gouge or selvage on one or both walls, intersecting the former, and therefore of later age. His third class differs from the first only in being wider and stronger and in carrying their ore in persistent bands or streaks. Like them, they stand at a high angle, and sometimes carry bismuth and antimony minerals. These veins are essentially gold-bearing, as even when carrying base-metal ores they contain little or no silver. According to Mr. T. B. Comstock, in an article on the geology of San Juan county,(a) the age of the veins of the district is probably post-Tertiary, and in their gradually varying strikes, in which there is little evidence of any systematic parallelism, he finds a tendency to radiate out from certain points which he considers centers of trachytic eruption. As, however, in the nomenclature and classification of eruptive rocks, he follows a system adopted by Dr. Endlich, and which is peculiar to that gentleman, the writer is at a loss to know what value to place on his evidence. He recognizes a primary and secondary system of veins, the latter of which cross the former, and makes the following provisory classification: First, those having a northwest trend, which are pre-eminently gray copper (freibergite) lodes; second, those with an east and west trend, the bismuth series of lodes, carrying occasionally nickel and molybdenum minerals; third, those with a northeast trend, the telluride series, with antimony and sulphides of the precious metals. From the data gathered by census experts, which are necessarily very incomplete, it appears that in San Juan county the northwest trend predominates; in the Uncompahgre district, comprising the northern portion of San Juan and the adjoining portion of Ouray county, the northeast trend predominates; while in Ouray county these two directions are about equally distributed, the east-and-west trend being in either case of subordinate importance.

SAN JUAN COUNTY.

San Juan county has an area of only 560 square miles, and includes the drainage area of the head of the Animas river. Its mines are principally found in the lofty peaks which surround the picturesque and elevated basin of Baker's park and its tributary valleys. They occur mainly in the older eruptive rocks, which here apparently rest directly on a base of gneiss and crystalline schists, presumably of Archæan age.

From Baker's park southward the Animas flows in deep cañons cut through later sedimentary rocks, which on the east consist mainly of the questionable series classed as Metamorphic-Palæozoic, and on the west of limestones of Carboniferous age. Of the later eruptive rocks which cover those of Secondary age it can only be said that, in view of the facts developed by recent more exact lithological studies, it is unfortunate that the term "trachyte" should have been so universally applied, inasmuch as late investigations of other districts where this rock was supposed to exist in large masses prove the normal type to be of extremely rare occurrence.

The mines reported by census experts belong to three principal districts: the Animas district, about Baker's park and Silverton; Eureka district, in the northeast portion of the county; and the Uncompahgre district, on the mountains between the Uncompahgre and Animas rivers, which apparently takes in also a portion of Ouray county. The region is undoubtedly one of exceptional richness in mineral developments, so that Mr. Comstock's statement that one-sixth of the area of the county is taken up by lode claims seems scarcely an exaggeration. The subjoined table gives a brief summary of the data obtained from producing mines by census experts:

Mine.	Country rock and vein.	Ore and gangue.
ANIMAS DISTRICT.		
Aspen Group	Greenish, indistinct porphyritic rock. Undeterminable. Vein: strike, NW.; dip, 80° SW.; width, 4 feet.	Galena and cerussite, with gray copper, rich in silver (freibergite).
Bowery	Altered felsite-porphyry. Vein: strike, N. 80° E.; dip, 80° S.; width, 10 feet.	"Carbonate" ore in quartz, with incrustations of ocher, azurite, and malachite. Gangue: altered country.
Cleveland Consolidated	Diorite (diabase?). Contains fibrous uralitic hornblende, which may have come from augite; chlorite, epidote, and calcite as decomposition products. Vein: strike, N. 27° W.; dip, 75° W.; width, 4 feet.	Massive freibergite in gangue of calcite and dolomite, with a little galena.
Diamond (Emblem lode)	Dioritic (?) rock with quartz in small grains. Vein vertical; strike, NW.; width, 4 feet.	Mixture of galena, freibergite, and chalcopyrite, with barite between quartz layers, forming banded vein material.
Empire	Quartz-bearing hornblende-diorite. Vein: strike, N. 45° W.; dip, 80° SW.; width, 7 feet.	Freibergite, galena, pyrite, and chalcopyrite in quartz.
Hercules	Diorite? (called syenite). Vein: strike, NW.; dip, 82° SW.; width, 10 feet.	Freibergite, pyrite, and some galena carrying silver.
Highland Mary	Biotite-gneiss. A dike of quartz-porphyry cuts the vein at right angles. Vein vertical; strike, N. 62° W.; average width, 10 feet.	Galena, freibergite, and chalcopyrite carrying silver, with trace of gold.
Jennie Parker	Diorite? (called syenite). Vein: strike, NW.; dip, 80° SW.; width, 5 feet.	Argentiferous galena, freibergite, and chalcopyrite. Quartz gangue.
Molas	Hanging wall white indistinctly stratified rock, consisting of quartz and feldspar—between a quartzite and a gneiss; foot wall decomposed porphyry. Vein vertical; strike, NE.; width, 6 feet.	Galena and barite, with stains of copper minerals.
North Star (Sultan mountain)	Very much decomposed porphyry. Vein: strike, N. 36° W.; dip, 65° SW.	Massive argentiferous galena, freibergite, and zincblende, with a little pyrite.
North Star (King Solomon mountain).	Greenish felsitic rock (diorite?). Vein: strike, N. 47° E.; dip, 74° NE.; width, 40 feet.	Argentiferous galena and cerussite, with freibergite.

a Trans. A. I. M. E., August, 1882.

Mine.	Country rock and vein.	Ore and gangue.
LAS ANIMAS DISTRICT—cont'd.		
Philadelphia	No specimen. Called "trachyte". Vein: strike, NW.; dip, 71° SW.; 2½ feet wide.	Freibergite; a little galena, with silver and some gold, in quartz gangue.
Pride of the West	Dark green compact decomposed rock, in part breccia. Undeterminable. Vein: strike, NW.; width, 28 feet.	Massive argentiferous galena, with chalcopyrite and freibergite.
EUREKA DISTRICT.		
Adelphi	Quartz-free plagioclase rock, with crystalline groundmass, probably diorite. Basic silicate changed to chlorite and calcite. Vein: strike, NE.; dip, 78° SE.; width, 3 feet.	Massive freibergite, with barite and some chalcopyrite.
Big Giant	White quartz-porphyry. Vein: strike, N. 50° E.; dip, 45° SE.; width, 23 feet.	Freibergite, argentiferous galena and pyrite, with quartz.
Bonanza tunnel	Porphyrite, with biotite, and probably hornblende, and a little quartz. Much calcite in films.	Occurs in two parallel veins, one carrying galena, the other freibergite and barite.
Columbia	Diorite? Vein: strike, NE.; dip, 80° SE.	Freibergite, with some galena and pyrite.
Mastodon	Decomposed greenish rock (diorite?). Vein: strike, N. 40° E.; dip, 70° SE.; width, 200 feet.	Massive argentiferous galena, with layers of quartz parallel to the cube faces; zincblende, pyrite, and chalcopyrite also occur.
Sioux City	Greenish decomposed rock (diorite?). Vein: strike, N.; dip, 78° E.; width, 4 feet.	Mainly galena; some gray copper.
Tom Moore	Greenish decomposed rock (diorite). Vein nearly vertical; strike, NE.; width, 60 feet; pay streaks, 9 inches to 5 feet.	Argentiferous galena and zincblende; massive.
UNCOMPAHGRE DISTRICT.		
Alabama	Greenish eruptive rock, with porphyritic crystals and included fragments of red quartzite. Vein: strike, NE.; dip, 70° E.; width, 25 feet.	Argentiferous galena and freibergite, with some pyrite and chalcopyrite. Gangue: quartz and feldspar.
Alaska	Diorite or diabase microscopically similar to that of the Adelphi. Vein: strike, NE.; dip, 80° SE.; width, 30 inches.	Chiefly freibergite, with some galena, and containing bismuth-silver in considerable quantity.
Annie Wood	Hanging wall (?) plagioclase-hornblende rock; diorite (?); foot wall (?) much altered porphyritic diabase; groundmass, crystalline. Vein: strike, N. 20° to 30° E.; dip, 80° E.; 5 feet wide.	Freibergite, stephanite, ruby silver, sulphide of bismuth with chalcopyrite.
Bonanza	Greenish felsite-porphyry much altered. Vein: strike, N. 65° E.; dip, 80° SE.	Freibergite and chalcopyrite with barite. Galena and pyrite also found. Quartz gangue.
Boston	Light-colored decomposed porphyry. Vein: strike, N. 20° E.; dip, 70° SE.; width, 4 feet.	Argentiferous galena with chalcopyrite and zincblende. Gangue: quartz and altered country.
Maid of the Mist	Plagioclase rock, with both hornblende and augite. Porphyrite or diabase (?). Vein: strike, N. 20° E.; dip, 65° E.	Argentiferous galena, freibergite and zincblende, with chalcopyrite and pyrite. Gangue: quartz and altered country.
Mammoth	Greenish decomposed porphyry; basic. Vein: strike, N. 10° E.; dip, 72° SE.; width on surface, 30 to 60 feet.	Freibergite, stephanite, ruby silver, native silver, sulphide of bismuth, with pyrite in quartz and altered country.
Red Cloud	Too much altered for determination. Vein: dip, 75° SE.; width, 3 feet.	Argentiferous galena, freibergite, zincblende, chalcopyrite, and pyrite, with some gold in quartz and altered country.
Red Rogers	Greenish country rock; decomposed porphyry. Vein: strike, N. 54° E.; dip, 80° SE.; width, 4 feet.	Freibergite, stephanite, ruby silver, with barite and quartz; a little galena.
Saxon	Green decomposed porphyry. Vein: strike, NE.; dip, 85° SE.; width, 30 to 40 feet.	Freibergite, galena, and stephanite (?), with some chalcopyrite. Gangue: quartz.

OURAY COUNTY.

Ouray county includes the northern and western slopes of the San Juan mountains, with certain outlying groups belonging geologically to the same mass, and the plateau country extending westward from thence to the Utah line, which is composed mainly of nearly horizontal Mesozoic beds.

The development of the precious metals has been thus far confined, as might be expected, to the eastern and more mountainous portion of the county. In the neighborhood of Ouray, which is near the northwest limit of the eruptive area of the San Juan mountains, erosion has exposed the underlying Palæozoic formations and a small area of what is presumably Archæan. The deposits of the northern portion of the Uncompahgre district occur mostly in the sedimentary beds, but in general are more or less closely connected with the overlying eruptive rocks. The veins belong more generally to the metamorphic type, although there seems to be no marked change in their mineral constitution. Mineral Farm seems to be a somewhat exceptionally rich deposit in limestone. In Sneffles district to the west of Ouray, in Upper San Miguel district, and in Iron Springs district near Ophir, to the south, the veins, like those of San Juan county, are in eruptive rocks, and stand at a high angle, many of them, especially in the latter district, carrying considerable gold. In the neighborhood of Rico, still farther south, the ores occur in sedimentary rocks, in general parallel with the stratification and with either foot or hanging wall of porphyry. They are essentially silver-bearing, and have a clay gangue material colored by hydrated oxides of iron and manganese.

Mine.	Country rock and vein.	Ore and gangue.
UNCOMPAHGRE DISTRICT.		
Begola	Blue-gray crystalline limestone, with chert segregations. Quartz-porphyry is said to occur.	Argentiferous galena, chalcopyrite, and pyrite, with freibergite and stibnite (?). Gangue: quartz and barite.
Dexter	Hanging wall greenish felsite-porphyry, and shale below. Foot wall shale, and quartzite below. Vein: strike, N. 20° E.; dip, 30° E. with country; width, 18 inches.	Massive argentiferous galena, native silver, stephanite, zincblende. Chalcopyrite and pyrite are said to occur. Gangue: quartz and altered country.
Golden Gate	White quartzite. Vein: strike N. 20° W.; dip, 80° W.; width, 4½ feet.	Argentiferous galena, freibergite, chalcopyrite, and pyrite in quartzite.
Grand View	Sandstone and conglomerate overlaid by eruptive rock. Vein: strike, N. 82° W.; dip, 77° S.; 18 inches wide.	Pyrite and chalcopyrite, carrying gold and silver, impregnating country rock.

Mine.	Country rock and vein.	Ore and gangue.
UNCOMPAHGRE DISTRICT—cont'd		
Riverside	Green porphyritic rock called trachyte. Vein: strike, N. 50° E.; dip, 78° S.; width, 4 feet.	Argentiferous galena, with pyrite and a little freibergite.
Union	Gray porphyritic rock called trachyte. Vein: strike, N. 40° W.; dip, 80° S.; width, 7 feet.	Argentiferous galena, chalcopyrite, and pyrite, and some stephanite.
SNEFFELS DISTRICT.		
Potosi	Greenish felsitic rock, locally called trachyte. Vein: strike, NE.; dip, 65° NW.	Freibergite, stephanite, and argentiferous galena, in white quartz and decomposed country.
Terrible	Probably altered diabase. Vein: strike, N. 80° W.; dip, 85° S ...	Mainly argentiferous galena. Gangue: quartz and altered country.
U. S. Depository	Undeterminable brecciated eruptive rock, locally called trachyte Vein: strike, N. 37° W.; dip, 75° SW.; width, 5½ feet.	Argentiferous galena, zincblende, and freibergite, with some pyrite.
Virginius	No specimen; locally called trachyte. Vein: strike, N. 32° W.; dip, 80° SW.; width, 4 feet.	Argentiferous galena and freibergite. Gangue: quartz and altered country rock.
Wheel of Fortune	Porphyritic rock like that generally called trachyte in the region. Vein: strike, N. 5° W.; dip, 65° W.; width, 5 feet.	Stephanite and freibergite. Gangue: quartz and porphyry.
Yankee Boy	No specimen; locally called trachyte. Vein: strike, N. 85° W.; dip, 85° S.	Argentiferous galena and zincblende, with barite and chalcopyrite. Gangue: quartz and altered country.
PIONEER DISTRICT.		
Grand View	Hanging wall decomposed porphyry or porphyrite; foot wall blue fine-grained dolomite. Deposit: dip, 45° to 72° NE., 2 to 14 feet thick.	Oxides of manganese, carrying silver, probably as chloride or sulphide.
Hope	Hanging wall porphyry (?). Foot wall limestone. Vein: dip, 25° NE.; deposit, 1 to 8 feet thick.	Hydrated iron and manganese oxides, carrying silver.
Newman	Hanging wall dark argillaceous shale. Foot wall porphyry or porphyrite. Vein: dip, 8° NW., 6 feet thick.	Iron-stained clayey mass, carrying silver, carbonate of lead, and other minerals.
UPPER SAN MIGUEL DISTRICT.		
Alta	Undeterminable; called trachyte. Dike of altered porphyry (?). Vein: strike, N. 75° W.; dip, 70° N.	Argentiferous galena and freibergite, with barite and quartz. Several parallel veins.
Cimmarron	Decomposed rock, probably porphyrite or diabase. Vein: strike, N. 22° E.; dip, 75° SE.; width, 3 feet.	Argentiferous galena, freibergite, chalcopyrite and pyrite, with some free gold. Gangue: light-colored felsitic rock, banded parallel with walls.
Gold King	Undeterminable. Porphyry (?) Vein: strike, N. 22° E.; dip, 75° SE.; width, 3 feet.	Gold-bearing quartz in altered country rock.
M. W. H., jr.	Greenish brecciated undeterminable eruptive rock called trachyte. Vein: strike, N. 16° W.; dip, 82° W.; width, 12 feet.	Quartz impregnated with galena, zincblende, chalcopyrite, and pyrite, carrying gold and silver. Gangue: quartz and altered country rock.
Palmyra	Locally called trachyte. Decomposed porphyry. Vein: strike, N. 25° W.; dip, 65° NE.; width, 4 feet.	Argentiferous galena, with barite and stibnite. Gangue: quartz and altered country.
Pandora & Oriental	Greenish undeterminable rock, locally called trachyte. Vein: strike, N. 72° E.; dip, 60° S.; width, 10 feet.	Auriferous quartz, with pyrite and chalcopyrite.
Smuggler	Greenish undeterminable breccia, locally called trachyte. Vein: strike, N. 18° W.; dip, 65° W.; width, 10 feet.	Native silver, stephanite, argentiferous galena, and zincblende. Gangue: quartz and altered country.
Summit	Undeterminable eruptive rock locally called trachyte. Vein: strike, NE.; dip, 75° NW.; width, 4 feet.	Argentiferous galena, cerussite, with stephanite and freibergite. Gangue: quartz and altered country.
IRON SPRING DISTRICT.		
Montezuma	Crystalline quartz-porphyry. Vein: strike, E. and W.; dip, 55° S.; width, 4½ feet.	Galena, cerussite, with some chalcopyrite, in quartz and altered country rock.
Nettie	White "siliceous limestone". (Porphyry?) Vein: strike, NW.; dip, 65° NE.; width, 4½ feet.	Galena, pyrite, and auriferous iron-stained quartz.
Nevada	Called trachyte. No specimen. Vein vertical; strike, NE.....	Galena, freibergite, chalcopyrite, and pyrite. Gangue: quartz and porphyry.
Osceola	Biotite-porphyrite. Vein: strike, N. 88° W.; dip, 70° N.; width, 4 feet.	Iron-stained auriferous quartz. Gangue: quartz and altered country.
Parson	Fine-grained very crystalline quartz-porphyry. Vein: strike, E. and W.; dip, 60 N.; width, 5 feet.	Argentiferous galena, zincblende, pyrite, and barite. Gangue: quartz and altered country.
Pike	Syenite or diorite (?) with a little quartz. Vein: strike, N. 15° E.; dip, 75° W.; width, 4 feet.	Argentiferous galena and pyrite, with a little gold, in gangue of dolomite and quartz.
Valley View	Called trachyte. No specimen. Vein, vertical; strike, NE.; dip, 90°; width, 3 feet.	Argentiferous galena and cerussite.
What Cheer	Quartz-porphyry, like Lincoln porphyry. Vein, vertical; strike, N. 40° E.; width, 4 feet.	Argentiferous galena and freibergite, with chalcopyrite, pyrite, and zincblende. Gangue: quartz and altered country.

LA PLATA COUNTY.

La Plata county lies to the south of Ouray and San Juan counties, and is largely a mesa country formed of approximately horizontal Mesozoic beds, protruding through which are the eruptive masses of the La Plata mountains and the Sierra el Late. The coal horizons underlie a large portion of the county, as well as a portion of western Ouray, and developments have been made in the more thickly settled portions.

In the census year its mines were mostly in the condition of prospects. A schedule was obtained from only one producing mine, the Comstock, in the California district, on the west side of the La Plata river, and 2½ miles north of Parrott City. Its ore deposit occurs in a dike of felsite-porphyry included in a reddish sandstone or quartzite, lithologically resembling those of the Upper Carboniferous of Park county. The deposit strikes north and south with the formation, dipping 65° to the eastward, and is apparently an impregnation or alteration of the country rock for about 6 feet in width near the hanging wall of the dike. Its ore is auriferous pyrite in a quartz gangue, with scattered spots of galena and gray copper. Specimens have been brought in from an extremely interesting deposit of copper glance in a coarse conglomerate resembling lithologically those which occur in the lower portion of the Triassic formation found to the west of Durango. A similar deposit is said to occur in the valley of the Rio Dolores, in the immediate neighborhood of a mass of eruptive rock which traverses the sedimentary conglomerate.

HINSDALE COUNTY.

Hinsdale county lies to the east of Ouray and San Juan counties, its area being mainly covered by eruptive rocks, with some exposures of underlying Archæan in the valleys tributary to the Lake fork of Gunnison river. Its mines occur mostly between Lake City and the crest of the range which divides this county from San Juan. In manner of occurrence of country rock and minerals they resemble those of the latter. Exceptionally, the country rock of the Ohio Consolidated mine, on Henson creek, 15 miles west of Lake City, is a fresh feldspar-basalt, containing olivine, which is largely altered to serpentine.

Mine.	Country rock and vein.	Ore and gangue.
GALENA DISTRICT.		
California	Porphyrite (?) Hanging wall resembles decomposed felsite-porphyry. Vein: strike N. 57° E.; dip, 55° NW.; banded structure, 4 feet wide.	Argentiferous galena, freibergite, zincblende, chalcopyrite, with calcite and rhodochrosite (?) in quartz gangue.
Ocean Wave	Gray eruptive, called trachyte. Vein: strike NE.; dip, 80° S.; width, 4 feet.	Argentiferous galena and freibergite; little native copper. Gangue: quartz and altered country.
Ohio Consolidated	Foot wall fresh feldspar-basalt, with olivine altered to serpentine; hanging wall much altered basic rock, possibly the same. Vein: strike N. 5° W.; dip, 73° W.; 3½ feet wide.	Freibergite and chalcopyrite. Gangue: quartz and altered country.
Palmetto	Gray diabase-porphyrite, with tendency to amygdaloidal structure. Vein: strike N. 25° E.; dip, 73° S.; 4 feet wide.	Chalcopyrite, stephanite, and ruby silver, with some gold in quartz gangue.
Silver Cord Extension	No specimen; locally called porphyry. Vein: strike N. 10° W.; dip, 85° E. No foot wall found.	Freibergite, with native silver and galena, chalcopyrite and zincblende. Gangue: quartz, with a little altered country.
Wray & Ute	Decomposed undeterminable rock, locally called trachyte. Vein: strike NE.; dip, 74° (?).	Freibergite, galena, and chalcopyrite; quartz gangue.
LAKE DISTRICT.		
Belle of the West	Decomposed light-colored orthoclase rock, with little quartz; locally called trachyte. Vein: strike N. 55° E.; dip, 62° S.; width, 18 inches.	Argentiferous galena, freibergite, zincblende, and auriferous chalcopyrite; quartz gangue.
PARK DISTRICT.		
Inez	No specimen; called diorite. Vein vertical; strike N. 34° E....	Stephanite and galena, with pyrite and chalcopyrite; quartz gangue.

SAGUACHE COUNTY.

Saguache county comprises the head of San Luis valley, with the slopes of the Sangre de Cristo range, which face it on the northeast, and the Cochetopa hills on the northwest, a volcanic mass, reaching from the southern end of the Sawatch range to the San Juan mountains.

No working mines of the precious metals are reported for the census year. On the western slope of the Sangre de Cristo, not far from Hayden's pass, occurs a rich deposit of red hematite iron ore in limestone (Carboniferous?), which is worked by the Colorado Coal and Iron Company, and to which a branch road has been extended from the Denver and Rio Grande railroad above Poncho Springs. Iron ore is also said to occur on the west slopes of the Cochetopa hills, in the valley of one of the creeks tributary to the Gunnison river.

RIO GRANDE COUNTY.

Rio Grande county comprises the very uppermost portion of the valley of the Rio Grande and the eastern end of the San Juan mountains, which is made up almost entirely of eruptive rocks, said to belong to the Tertiary volcanics.

Little Annie mine, in the Summit mining district, is the most important producing mine. It is situated about 28 miles to the southward of Del Norte, at the head of Alamosa creek. It is an exceptionally rich deposit of free gold in quartz 45 feet in width at the surface. The quartz is a peculiarly cellular rock, and the cavities are supposed to be those left by the leaching out of feldspar crystals. The country rock is probably an older porphyry. This could not be determined for want of a specimen; but it has been suggested, with considerable appearance of probability, that the so-called vein is an altered porphyry dike impregnated with mineral.

GEOLOGICAL SKETCH OF WYOMING.

The territory of Wyoming lies to the north of Colorado, having a corresponding area as measured by degrees of latitude and longitude, but set off 2° of longitude to the westward.

Although directly in the line of the main Rocky Mountain uplift, the larger portion of its area is a plain or mesa country. The Colorado range extends a short distance north of the boundary of that state, but with a very much diminished elevation. In the northwestern corner of the territory is a considerable mountain area, occupied principally by the Wind River, Shoshone, and Big Horn ranges, which are connected with the northern continuation of the Colorado range by low east and west ridges, the Sweetwater and the Seminole mountains. In the extreme northeastern portion of the territory a portion of the Black Hills uplift is included within its boundaries.

With these exceptions its area consists of broad grassy valleys or Tertiary mesas, which either form arid deserts or are covered with a somewhat scanty growth of nutritious grasses. But few large streams are found in the territory, although within its area are some of the sources of the three great river systems of the country, viz, the Green or Colorado river, which flows southward through its center; the Snake Fork of the Columbia, which takes its rise in the northwestern portions; and the Platte, Cheyenne, Powder, and Wind rivers, important tributaries to the great Missouri River system. With the exception, therefore, of narrow strips of alluvial soil in the bottom lands of these streams and their tributaries, it is of little value for agricultural purposes. On the other hand, the immense stretch of grassy plains available for grazing constitutes its great wealth.

Our geographical and geological knowledge of the territory is mainly obtained from the reports of the Exploration of the Fortieth Parallel, whose field of labor covers a narrow strip along its southern border, and from detached notes on the same field made by the Hayden survey. The last season's field-work of this survey (in 1878) covered a considerable portion of the western and northern areas of the territory, but its results are not yet printed. (*a*)

GENERAL GEOLOGY.—It is doubtful whether any portion of this territory emerged from the surface of the ocean during the Palæozoic and Mesozoic eras. At the most, land areas, if they existed, were confined to the northwestern portion, consisting of what now constitutes the Wind River range, and possibly portions of the adjoining mountain areas. The mountains of Colorado find their continuation in a system of submerged reefs and small islands, stretching in a direction a little east of north to the Black hills of Dakota, and branching off in a northwesterly and westerly direction to connect with the Wind River range. In this area sedimentation, fed by material derived from the land areas of Colorado on the south, of Utah and Idaho on the west, and of Montana and the Black hills of Dakota on the north and east, went on without any important interruption until the close of the Cretaceous. As already noted in Colorado, there was a probable continental elevation toward the close of this period, resulting in the partial inclosure of the basin which forms the central portion of the territory, so that its waters became gradually fresher, and were finally shut off from all communication with the ocean. The conditions of this period were particularly favorable for the formation of coal, and the upper portion of the Cretaceous, wherever it outcrops throughout the territory, has been found to yield an abundance of this valuable mineral. After the great dynamic movement at the close of the Cretaceous large areas were still beneath the surface of fresh-water Tertiary seas, in which deposition went on with great activity. It is as yet too early to outline definitely the areas of these different seas, but it is known that within the Tertiary system there exist important developments of beds of the Eocene, Miocene, and Pliocene periods. The wealth of fossil remains of animals, fishes, and plants which have been exhumed from these beds has already given them a world-wide renown among students of the evolution of life on the globe.

The surface changes during the Quaternary have been comparatively small as compared with those of the mountain regions adjoining; and yet enormous masses of the beds deposited in the Tertiary era have been swept away. In the Wind River mountains a local system of glaciers existed relatively greater even than those of Colorado, living relics of which are said still to exist in the higher parts of the mountains. Of eruptive rocks there seems to be a singularly small development in this great area. As far as known, they are mainly confined to the Yellowstone park, in the extreme northwestern portion of the territory, whose geysers, generally considered as intimately connected with recent volcanic action, eclipse the hitherto unrivaled springs of the volcanic island of Iceland. In the midst of the Tertiary plains of the great Green River basin is found a small flow of leucite-lava, the only occurrence of this mineral, which is characteristic of the lavas of Vesuvius, hitherto discovered on the American continent. It is not to be wondered at that we have but little information about earlier eruptive rocks, since so much of the area of the country is covered by sediments deposited since their eruption and the Archæan areas in which they might be found are as yet comparatively unstudied.

GOLD AND SILVER.—As might be inferred from the above brief sketch of its geological structure, Wyoming can scarcely rival its northern and southern neighbors as a producer of the precious metals. Its actual resources have as yet, however, been scarcely developed, partly because the broad plain areas offer little inducement to the prospector, and partly because he has hitherto been debarred from the northern mountain areas by the Indian tribes to whose reservation they belonged. The only discoveries of ores of these metals which are known to the writer are confined to the Medicine Bow range, a northern offshoot of the Colorado range, to the south of the Laramie plains; to the Sweetwater and Seminole mountains, a group of hills running east and west from the northern end of the Laramie hills to the Wind River mountains; and to the mining districts near South Pass, at the southeastern end of the Wind River mountains. From the latter region alone were returns obtained by the census experts.

The Archæan nucleus of the Wind River mountains consists mainly of granite, on whose northeastern flanks rest the Palæozoic and Mesozoic formations; while on the southwest the Tertiary beds of the Green River basin come directly in contact with it. At the southeastern extremity of the range the granites give way to a series of schistose rocks, prevailingly gneiss and mica-schist, whose area extends out for some distance beyond the actual

a The writer has been favored with a glance at the topographical and geological maps of this report, from which part of the data herein contained are derived.

mountain uplift. In the foot-hills of the range, near the South pass, are the California, Miner's Delight, and Shoshone districts, the former near Atlantic City, and the latter near South Pass City. Mines were first discovered here in the fall of 1867, and the region was the scene of considerable excitement in the following year. Wild-cat speculation, danger from the Indians, and other causes have combined to prevent its proper development; so that, although the mines are now almost deserted, it would seem that their abandonment has not been necessarily due to want of good ores. From the data obtained, they seem to be mainly free-milling gold ores, occurring either in quartz veins or as impregnations of the country rock, which is mainly gneiss of both micaceous and hornblendic varieties. It is difficult to form a clear idea of the exact geological relations of the deposits, but they would seem to be in some respects analogous to those of the Black hills. Galena and copper ores are also said to have been found in the vicinity, but their exact location is not given.

Copper ores have recently been developed near the Platte river to the northwest of Fort Laramie. From the boundary of Colorado northward to the Platte river extends a broad flat ridge, known as the Laramie hills, whose surface is made up of Archæan rocks, from which the Palæozoic and Mesozoic beds, which originally covered it, have been removed by erosion. From Laramie peak, the northern extremity of this ridge, which itself was possibly an island in the Cambrian ocean, an irregular reef of Archæan rocks extended in a direction a little north of east toward the Black hills. Portions of this reef, which in Tertiary times projected above the water, now form an irregular group of hills, known as the Rawhide buttes. At the southern base of these hills, in the sedimentary rocks which rest against the Archæan, occur the deposits of copper above mentioned. The ore consists of carbonates, oxides, and silicates of copper, containing no silver, and, thus far, not sufficient sulphur to make a matte. To what geological horizon the country rock inclosing these ores belongs is not known, nor the character of the deposits; but it seems probable that they are rather impregnations of a certain bed than a vein crossing the stratification.

COAL AND IRON.—The actual development of coal in Wyoming is already very considerable, and its possibilities are immense. With the exception of the mountain ridges, the entire area of the territory may be said to be underlaid by the coal formation. Over a very great portion of this area, it is true, this formation is so deeply buried beneath Tertiary deposits that it is practically unavailable. On the other hand, the coal formations are by no means absolutely horizontal over all the plain country, but have been brought to the surface by various geological movements, so that the actually known extent of its outcrops is very great. The two largest basins are those of the Laramie plains and of the Green River basin. In the former coal is worked extensively at Carbon, on the Union Pacific railroad; in the latter, coal beds have been opened at Black Buttes and Point of Rocks, on the east, and at Rock Springs, on the west of a synclinal basin lying east of Green river, while the outcrops of a second basin to the west of Green river have been found extending all along the western borders of the territory and beyond the line in Utah from near the head of Bear river, following the valley of that stream and of the south fork of Snake river as far as the junction of the latter with Henry's fork, a distance, in round numbers, of 175 miles. Outcrops have also been found extending around the northwestern point of Wind River range, at the head of Gros Ventre and Wind rivers, and at various points among the bays of the Big Horn mountains and the Black hills of Dakota. They have also been found not far from the copper mines to the north of Laramie peak. The only actual working mines, however, are those along the line of the Union Pacific railroad, which are either owned by or are indirectly under the control of that corporation. Iron ore has been discovered in immense masses in the Laramie hills at the head of Horse creek. This ore is magnetic. The specimens as yet tested have proved to contain too large a percentage of titanium to be of marketable value, but it is by no means certain that a more careful investigation may not discover beds comparatively free from this injurious constituent. A valuable deposit of remarkably pure red hematite also exists in the Carboniferous strata resting against Rawlings peak. The ore was used for some time as a mineral paint, but the mine has of late years for some unknown reason been abandoned. Petroleum is found in the rocks of the Cretaceous formation at many points, and oil of excellent quality for lubricating purposes has been obtained in small quantities; but the practical value of this formation as an oil producer has not yet been thoroughly tested. At various points in the Tertiary plains are beds of dried-up lakes containing valuable deposits of alkaline salts. These are specially frequent to the north of the Union Pacific railroad, between the Platte and Green rivers, and in one case a deposit of solid sulphate of soda 15 feet in thickness has been proved. Their actual development is awaiting the advent of some enterprising manufacturing chemist.

SWEETWATER COUNTY.

Mine.	Country rock and vein.	Ore and gangue.
CALIFORNIA DISTRICT.		
American	Fine-grained gneiss. Vein: strike, NE.; dip, S.; 2 to 8 feet wide.	Free gold in quartz.
Buckeye State	Hornblende-gneiss. Vein: strike, E. and W.; dip, N.; width irregular, 8 inches to 12 feet.	Do.
Caribou	Archæan schists. Vein: strike, NE.; dip, N.; width irregular, 8 inches to 5 feet.	Gold-bearing quartz.
Manchester	Amphibolite and gneiss. Vein: strike, NW.; dip, 45° S.; width irregular, 4 to 16 feet.	Do.
Mary Ellen	"Black granite"; no specimens; probably gneiss. Vein: strike, NE.; dip, W; average 1 foot thick. Irregular on hanging wall.	Free gold.
Victoria	Gneiss. Vein: strike, NE.; dip SE.; 1 to 4 feet wide	Do.
MINERS' DELIGHT DISTRICT.		
Hartley	Compact dark gneiss. Vein: strike, SW.; dip, S.; 6 inches to 2 feet in width.	Free gold in quartz and decomposed country.
Miners' Delight	Fine-grained gneiss. Vein: strike, NE.; dip, S.; 1 to 6 feet in width.	Free gold, with little silver in quartz.
Sidney Johnston	Gneiss and schists. Vein: strike, NE.; dip, S.; width, 6 inches to 5 feet in width.	Free gold in quartz.
Yellow Jacket	Gneiss and schists. Vein: strike, NW.; dip, S.; 1 to 4 feet in width.	Do.
SHOSHONE DISTRICT.		
Curieo	Apparently Archæan gneiss. Vein: strike, NW.; dip, S.; 2 to 5 feet wide.	Do.

GEOLOGICAL SKETCH OF THE BLACK HILLS OF DAKOTA. (a)

The Black hills of Dakota constitute a wooded island rising from 2,000 to 3,000 feet above the treeless plains of Dakota, quite isolated from the main chain of the Rocky mountains, whose foot-hills lie 100 miles further to the west. Their uplift forms an oval some 120 miles in length by 50 in extreme width, its longer axis having a direction a little to the west of north. The surrounding plain or mesa country is covered by practically horizontal beds of Cretaceous and overlying Tertiary formations.

Their geological structure is that of a singularly regular quaquaversal having a central nucleus of Archæan schists, on which rest beds of the Palæozoic and Mesozoic formations dipping away from it in every direction, the outcrops of the latter forming a series of fringing reefs, or so-called hog-back ridges, which completely encircle the island. The area in which the Archæan rocks are exposed occupies the eastern and higher portion of the hills, and also forms an oval some 56 miles in length and 24 in extreme width, its longer axis running north and south. The northwestern portion of the hills is covered by nearly horizontal beds of the Palæozoic formation, patches of which are still left in the Archæan area, while the steeper dips of the quaquaversal are found as a rule only near the foot-hills.

The Archæan rocks of the Black hills are divided by Mr. Newton into two series, an older and a newer Archæan, the former, in general, occupying the southwestern portion of the oval area above mentioned, and the latter (the newer Archæan) the northeastern portion. The latter he considers to closely resemble the Huronian of the east, and it is certainly unlike any Archæan formation yet studied in the Rocky mountains, except that of the Red Creek area in Wyoming, (b) which was also considered as corresponding to the eastern Huronian, and resembles it lithologically. The older Archæan is also somewhat different from that of Colorado, in that it contains but little gneiss. The granite which occurs in it, however, would not seem to form so much of a distinctive character from this Archæan as was thought by Mr. Newton, since it is apparently an exaggerated form of the pegmatite, which is largely developed in Colorado in secondary veins and irregular masses traversing the gneiss and schists. This older Archæan consists, according to Mr. Newton, of quartzose, garnetiferous, and ferruginous mica-schists, chloritic schists, amphibolites, and subordinate gneiss, with interlaminated veins of quartz carrying gold. In these occur large masses of granite of lenticular shape, conforming in general with the stratification of the schists, and made up of very large individuals of quartz, feldspar, and mica, crystalline in structure, but not always in complete crystals. Tourmaline crystals are quite common in the granite. This granite Mr. Newton regards, from the fact that it sometimes incloses fragments of schist and has polished contact surfaces, as distinctly of an eruptive origin, but as erupted in pre-Cambrian times. The rocks of the newer Archæan are, according to him, not essentially different in mineralogical composition, but are characterized by a much finer texture. They consist of micaceous clay slates, siliceous slates, hydro-mica schists, and quartzite. Quartzite forms an important constituent, often carries a certain amount of mica, and occurs in powerful beds from 50 to 200 and sometimes 500 feet thick. The mica-schists are often garnetiferous, and contain also staurotide crystals.

a The data for this sketch, additional to that gathered by census experts, were obtained from *A Report on the Geology and Resources of the Black Hills of Dakota*, by Henry Newton and Walter P. Jenney, observations made in 1875 and published in 1880, and from a paper by W. B. Devereux on "*The occurrence of gold in the Potsdam formation*", Trans. A. I. M. E., February, 1882.

b *Geological Exploration of the Fortieth Parallel*, vol. II, Descriptive Geology, page 369.

Gneiss also occurs, but rarely. To these should be added, from data furnished by the census specimens, a series of very fine phyllites and some actinolite schists. Interlaminated lens-shaped bodies of quartz are also noted in this series by Mr. Newton, and are by him supposed to be auriferous. Mr. Jenney considers these quartz bodies as differing in the two series, though the reasons for this difference are not apparent. Both are parallel with that bedding, and neither traverses it; both carry gold, but those in the older series he considers interlaminated fissure veins and continuous, and those in the newer series as segregated veins and not continuous. The enormous quartz bodies which have yielded the principal gold product of this region belong to the latter class.

Overlying unconformably these Archæan schists is a thickness, in round numbers, of 2,500 feet of Palæozoic and Mesozoic beds, which, according to Mr. Newton, are entirely conformable within themselves. These consist first of a thickness of 250 feet of calcareous sandstones and quartzites, having a conglomerate with calcareous cement at or near the base and local developments of glauconite grains in the upper part. In these are found well-recognized fossils of the Potsdam formation, which is classed by Mr. Newton as Silurian, but which it is now more common to group under the Cambrian epoch. Above the Potsdam sandstones are pinkish and gray limestones, passing up by a gradual transition into red and variegated sandstones, in the former of which are found well-recognized Carboniferous types. Over these are the red Triassic sandstone beds, succeeded by variegated clays and marls, with a little limestone of Jurassic age and coarse yellow sandstone, with clays and shales of the Cretaceous formation. The thicknesses given by Mr. Newton are 690 feet for the Carboniferous group and 1,440 feet for the entire Mesozoic system. The striking features in this series of deposits are the apparent absence of representatives of the formations included between the Cambrian and Carboniferous and the relative thinness of the entire series as compared with sections found in other parts of the country. The latter fact is less surprising when it is considered that the tendency of the Rocky Mountain deposits has been observed to be a thinning out toward the east, and that the Black hills were an island at least 100 miles east of the Archæan shore-line. Whether the apparent gap in the series signifies that there was actually a cessation of deposition during Silurian and Devonian times, or whether representatives of these formations exist but have not yet been detected, is a question that can only be definitely determined by far more detailed studies than have yet been made.

The geology of the Black hills is of singular interest, not only to the general but to the economic geologist, and the facts already obtained show that its history has been a remarkably varied one. According to Mr. Newton, there is evidence that the newer Archæan is unconformable to the older; in other words, that dynamic movements took place, and land existed here which was acted on by erosion before the close of the Archæan. The conglomerate at the base of the Potsdam bears unmistakable evidence of having been a beach or shore formation, and shows that new land appeared at the close of the Archæan, while the comparatively horizontal position of the Potsdam and Carboniferous beds in elevated portions of the hills seems to indicate a gradual subsidence during the Cambrian, which, if the Devonian be really wanting, must have been followed by a sufficient elevation to prevent the sediments of that period covering its area. This elevation, however, must have been of such a gradual character that the formations were not disturbed, inasmuch as the Carboniferous beds were deposited with perfect conformity on the Cambrian. At the close of the Cretaceous the area of the hills was again lifted above the sea and a second conglomerate deposited round its shores. Erosion during this time removed a large portion of the Mesozoic and Palæozoic beds to form the surrounding Tertiaries; and that elevation has gone on since Tertiary times seems to be proved by the evidence of conglomerate beds more recent than the Tertiary, which exist, according to Mr. Jenney, 300 feet above the present stream beds, and are made up of bowlders of the Archæan and other rocks from the interior of the hills. These gravels or conglomerates Mr. Jenney regards as quite distinct from those of the present stream-beds, and as probably dating back to the close of the Glacial epoch. There are thus four different ages of gravel formations, all of which, except possibly the third, have been proved to be gold-bearing:

First. The Potsdam conglomerate.
Second. That at the close of the Tertiary.
Third. That at the close of the Glacial period.
Fourth. The recent.

Of eruptive or igneous rocks, of which there are abundant outbursts, especially in the northern portion of the hills, where the richest mineral deposits have hitherto been found, Mr. Newton recognizes only those of Tertiary age. It seems probable, however, that had not his untimely death cut short his observations a further study might have led him to modify this opinion. Mr. Caswell, to whom the specimens of eruptive rock were submitted for microscopical examination, says himself that in several cases he would have classed the rocks as quartz or feldspar-porphyries had not their geological relations, as described to him, forbidden it. Among the census specimens are some which undoubtedly belong to these types. They are the rocks which are described by Mr. Devereux as breaking in dikes through the Potsdam conglomerate and spreading out over its surface in the neighborhood of Lead City. Moreover, the structural relations of the eruptive masses which form many of the prominent peaks, and which, according to Mr. Newton, have uplifted the surrounding sedimentary beds, belong rather to the type of earlier intrusive eruptives, analogous to the laccolitic bodies, than to the Tertiary volcanics, which as a rule have flowed out on the surface without exercising any considerable disturbing influence on the sedimentary beds through which they have passed.

To the economic geologist the most interesting fact in the geology of this region is the definite date given to the formation of the gold deposits. The Potsdam conglomerate is in places an actual placer deposit formed on the beach of the Cambrian ocean from the *débris* of veins at present worked in the Archæan. The gold of the Black hills is therefore distinctly of Archæan age. Mr. Devereux also recognizes a probable secondary deposition, which he considers as probably resulting from chemical solution of gold contained in the Potsdam conglomerate and redeposited in the underlying schists. He also seems to consider the deposition of certain silver-bearing ores in the neighborhood of Bald mountain, a region traversed by bodies of porphyry in the forms of dikes and sheets, which occur in the quartzite adjoining these bodies, as dependent on the eruption of the porphyry. If the section which he gives of the region in the neighborhood of Deadwood gulch be correct, the porphyry must be of subsequent date to the erosion of the Cretaceous and Palæozoic rocks, and therefore probably post-Cretaceous.

ORE DEPOSITS.—The most characteristic ores of the Black hills are auriferous pyrites, now almost completely oxidized, impregnating lenticular masses of quartz, and portions of the adjoining schist in the newer Archæan of Newton. Owing to the decomposed condition of the rock and its freedom from injurious metallic combinations these ores are so exceptionally easy of amalgamation in the stamp-mill that they yield a profitable return, even when carrying only from $4 to $6 per ton in gold. These deposits have been mainly developed in the extreme northern portion of the Archæan area at the head of the Whitewood gulch, in the vicinity of Lead, Central, and Deadwood cities. The country rock here consists of fine-grained mica-schists, argillites, or phyllites, with numerous interlaminated lenticular bodies of quartz parallel with the stratification, which has a prevailing northwesterly strike and a dip of from 50° to 75° to the northeast. The ore belts are from 40 to 200, 300, and even 500 feet in width, and consist of impregnations of these quartz masses and portions of the adjoining country rock with iron oxide, resulting from the decomposition of pyrites carrying fine gold. In these belts are barren streaks or "horses" of country rock and dikes or bodies of what is locally called porphyry. It is evident that these deposits have none of the characteristics of a true fissure vein, though they are none the less valuable on that account. It is probable also that the individual ore bodies, or lenses, are of limited extent both horizontally and vertically, or, as Mr. Jenney says, not continuous. This fact is not necessarily derogatory to the deposits as a whole, since, while one lens may pinch out, another may be found contiguous, though not exactly in the same plane. Moreover, in spite of the popular delusion in favor of fissure veins extending to the center of the earth, all known facts go to prove that all ore bodies are limited in extent, the difference between one and another being merely in the extent of the limit. Horizontally the limit is easily traced, although in depth it is sometimes beyond the present reach of practical mine development.

Another important source of gold is the cement or Potsdam conglomerate, which, though its ore is milled in the same manner as the vein material, is in fact an ancient placer deposit. It is only of local extent, is of varying thickness, and is made up of rounded and angular fragments of quartz, hematite, and Archæan schists, often with ferruginous cement, and, according to Mr. Devereux, carries free gold, distributed in an exactly analogous manner to that found in modern placers. In many cases the cement deposit is worked as a horizontal vein, while a vertical vein is described as occurring immediately beneath it. Whether Mr. Devereux would consider all these vertical veins as instances of later deposition is not known to the writer.

In mines reported from the Bald Mountain district, at the head of the Whitewood gulch, the reports show a different class of deposits, which consist of chlorides of silver and iron oxide, carrying gold, impregnating the quartzite strata to a thickness of several feet. These are probably the deposits which Mr. Devereux considers as a later formation, and connected with the porphyry outbreaks. No specimens of porphyry were returned by experts, but the district is apparently in the neighborhood of Terry's peak, the rock of which Mr. Caswell reports as a granitic rhyolite, with a completely crystalline groundmass, closely resembling granite- or felsite-porphyry.

In the Bear Butte district, 10 or 12 miles to the east of Deadwood, irregular deposits of argentiferous galena and cerussite, with oxides of iron carrying both gold and silver, occur in limestones and quartzites, sometimes parallel to the stratification, and again crossing it. Gold is also obtained from a conglomerate or breccia largely made up of fragments of what is apparently felsite-porphyry. The geological relations of this class of deposits are not clear.

In Pennington county, in the central portion of the hills, free-milling gold ore is found in Archæan rocks in the Rockford, Cross, and Newton Forks districts; and to judge from the specimens of country rock sent in they occur apparently in the same Archæan formation as that of the Whitewood district, although, according to Mr. Newton's map, a portion at least of these mines would be included in the older series. It is to be noted, however, that the geological outlines of the map are confessedly imperfect, owing to the fact that Mr. Newton's material had to be worked up by another hand than his own. In the Cross district the ore-body seems to be the impregnation of a mass of actinolite-biotite schist, instead of quartz, included within the mica-schist country rock. It is to be noted, however, that in these districts, while, according to the census schedules, the formation strikes nearly north and south, its dip in the Rockford and Cross districts is to the eastward, and in the Newton Forks district to the west.

In Custer county, still farther south, are the Cole and Custer districts, in which the same lenticular masses of quartz, carrying free gold, occur in mica-schists. Both these districts are included in Newton's older Archæan area. The specimens of country rock sent in are micaceous schists, carrying considerable quartz, and sometimes

garnetiferous, while the ore-bodies, in addition to the quartz, are sometimes amphibole-schists, and in one case consist entirely of fibrous tremolite. Associated with the gold is frequently a little silver. The prevailing strike is here also nearly north and south, and the dip to the westward.

Three miles to the northwest of Custer City is a mica mine, in one of the bodies of granite described by Mr. Newton. In its general character it resembles the pegmatites of Colorado, but the size of the individual constituents is actually gigantic, and the association of minerals is somewhat remarkable. The data are not sufficient to determine the exact geological relations of the rocks. The foot wall of mica-schist strikes north and south, and dips 40° to the westward. Above this a thickness of four feet is worked for mica, which occurs in large sheets over a foot in diameter, usually nearly perpendicular to the foot wall. Specimens from the zone next above the mica show albite (var. clevelandite), labradorite, beryl in crystals 2 to 3 inches in diameter, and a lithia-mica in small leaves. Above this is pure milky quartz of great thickness, said to extend to the top of the hill, over 100 feet above the vein. Whether these deposits prove of economic value or not, a visit to it would evidently be fruitful in interesting results to the mineralogist.

PLACER DEPOSITS.—The placer deposits of the Black hills are apparently of great extent and richness; but, except those immediately adjoining the beds of the present streams, which are largely worked out, they have as yet proved of little practical value, owing to the difficulty of procuring a sufficient supply of water. As already stated, Mr. Jenney makes four different ages of gravel deposits. The earliest, or Potsdam conglomerate, is worked as a deep mine, and its ore is regularly crushed in the stamp-mills. Of the pre-Tertiary conglomerate no data are available as to its contents in gold. It occurs, according to Jenney, under the Miocene beds at the mouths of Spring and Rapid creeks, forming a bed 6 feet in thickness, made up of bowlders of granite, trachyte, slate, quartzite, and quartz. Mr. Jenney says the glacial deposit which occurs sometimes 300 feet above the present bed of the creek has been proved to be rich by actual test, but cannot be worked, owing to the want of a sufficient head of water. The recent deposits of the present cañons, according to data furnished by the census, have been worked principally in the Archæan area, and have an average depth of from 4 to 30 feet. Mr. Devereux gives some interesting facts concerning the placer deposits of Deadwood and its tributary gulches. According to him, these are formed in part from the disintegration of the Potsdam conglomerate bed and in part from the actual wearing away of the quartz deposits in the Archæan, which accounts for their exceeding richness; the placers of Black Tail gulch were entirely derived from the disintegration of the cement, as the Archæan, at the head of the gulch, has not been exposed to erosion in recent times. To account for the known superior fineness of placer gold over that in veins, he assumes that the chemical agencies to which the gold has been subjected since it was liberated from the vein have acted more energetically on the silver than on the gold. To prove this he shows from actual figures that while the average fineness of the gold from five different veins was 0.830, gold from the placers, which would have resulted from the disintegration of these veins, averaged about 0.900, and that the small, thin pieces of gold, which had proportionately greater surfaces than the coarser particles, were finer than the latter.

The other minerals of economic importance found in the Black Hills region are beds of gypsum, which occur in the Triassic formation, and of coal, which is mined in the Cretaceous beds to the northwest of the hills.

LAWRENCE COUNTY.

Mine.	Country rock and remarks.	Ore and gangue.
WHITEWOOD DISTRICT.		
Badger	Hanging wall felsitic rock with stratified appearance, probably eruptive. Foot wall mica-schist, with some chlorite. Ore belt vertical. Strike, NW., 200 feet wide; capped by conglomerate.	Free-milling auriferous quartz.
Black Tail	Conglomerate (cement deposit) of fragments of Archæan schist. Compact felsite overlying conglomerate. Ore body, horizontal, 14 feet thick.	Free gold in conglomerate.
Caledonia	Hanging wall phyllite, with pyrite and garnet. Foot wall mica-schist with chloritic layers. A felsite occurs whose relation is not clear. Strike, N. 5° W.; dip, 51° E. (?); two ore belts, one 40 feet, the other 182 feet wide.	Pyritiferous chloritic schists carrying gold. Chlorite apparently comes from actinolite.
Champion	Cap and hanging wall felsite-porphyry. Foot wall calcareous quartzite. Horses in vertical part of vein composed of carbonates of iron, lime, etc. Strike of formation, NE.; dip, 75° E.; ore belt, 35 feet wide.	In part steeply inclined beds, in part horizontal beds resting on upturned edges of Archæan, overlaid by porphyry.
Deadwood-Terra	Hanging wall chlorite-schist with garnet. Foot wall mica-slate formation. Strike, NW.; dip, 50° to 75° NE.	Ferruginous quartz carrying gold and a little silver scattered through a belt of Archæan, 250 feet wide.
Esmeralda	Probably Archæan. No specimens. Overlaid by conglomerate (cement).	Free gold in horizontal cement deposit, and segregated quartz lenses in schists below.
Fairview	Archæan overlaid by conglomerate. Strike, NW.; dip, 50° to 75° NE.; cement, 20 feet thick; ore belt, 200 feet wide; felsite (?), above the conglomerate.	Gold-bearing cement and quartz lenses in iron-stained mica-schist.
Father De Smet	Chloritic schists. Strike, NW.; dip, 50° to 75° NE.; ore belt, 150 feet wide, with horses of barren rock.	Quartz lenses and altered schists, with pyrite; gold-bearing.
Flora Bell	Phyllite on hanging wall. Altered schist on foot wall. Horizontal conglomerate capped by felsite (?) above. Strike, NE.; dip, 85° W.	Gold-bearing cement and schist impregnated with quartz.
Giant & Old Abe	Archæan schists impregnated with iron. Strike, NW.; dip, 50° to 75° NE.; ore belt, 60 feet wide.	Ferruginous gold-bearing quartz, with a little pyrite, impregnating schists.
Goldfinch	Quartz conglomerate, overlaid by fine-grained Potsdam sandstone; quartzite (?) below.	Cement 5 to 6 feet thick, carrying free gold.

LAWRENCE COUNTY—Continued.

Mine.	Country rock and remarks.	Ore and gangue.
WHITEWOOD DISTRICT—cont'd.		
Golden Gate	Fine-grained mica-schists. Strike, NW.; dip, 50° to 75° NE.; ore belt, 25 feet wide.	Quartz and schists, with little pyrite; gold-bearing.
Golden Terra	Mica-slate on hanging wall. Mica-schist, rich in quartz and microscopic ore grains, on foot wall. Strike, NW.; dip, 50° to 75° NE.; ore belt 300 feet wide, with "porphyry" dikes and horses of slate.	Ferruginous quartz, with little pyrite in slate.
Gopher	Fine-grained compact mica-schist. Strike, NW.; dip, 50° to 75° NE.; ore belt 60 feet wide.	Lenses of quartz and decomposed schists; gold-bearing, with little pyrite.
Great Eastern	Conglomerate of quartz and some schist, overlaid by quartz-porphyry. Dip, 15° E.; 3 feet thick; resting on schists.	Free gold in cement.
Hidden Treasure	Conglomerate of quartz and schist fragments; horizontal. Thickness, 20 feet to *nil*. Felsite above, Archæan below.	Free gold in cement.
Highland	Archæan schists. Argillite on foot wall; lenticular bodies of felsite (?) parallel with the formation. Strike, NW.; dip, 50° to 75° NE.; ore belt 550 feet wide, less felsite bodies.	Ferruginous quartz and schist, with little pyrite; gold-bearing.
High Lode	Conglomerate, resting on fine-grained Archæan schists, overlaid by Potsdam sandstone. Horizontal; 3 feet thick.	Free gold in cement.
Homestake	Archæan schists and porphyry (?) bodies. Strike, N. 10° to 30° W.; dip, 51° E.; ore belt 40 feet wide.	Ferruginous quartz and schist, with little pyrite, carrying free gold.
Louella	Conglomerate, resting on Archæan, overlaid by sandstone. Dip, 30° E.; 7 feet thick.	Free gold in cement.
Ore Cash	Felsite-porphyry. Strike, NW.; dip, 30° NE.; ore belt 150 feet wide.	Gold-bearing hematite and limonite in quartz.
Pecche	Conglomerate, capped by felsite and resting on Archæan schists. Strike of latter, N. 5° W.	Free gold in cement, and gold-bearing quartz and schists in Archæan.
Portland	Quartzitic sandstone (Potsdam?). Strike, NW.; dip, 8° SW.; deposit, a nearly horizontal bed and a vertical vein below. Horizontal vein, 7 feet thick; vertical; strike SW., 5 feet thick.	Quartzite, impregnated with horn-silver, iron oxide, and some gold.
Rattler	Hanging wall quartzite-schist, foot wall mica-schist. Strike, NW.; dip, 75° NE.; 40 feet wide.	Ferruginous gold-bearing quartz.
Scandinavian	Archæan schists. Ore belt 38 feet wide; strike, NE.; dip, 85° NW.	Quartzose iron-stained masses, carrying gold.
Sir Roderick Dhu	Chloritic schists and mica-slates. Ore, lenticular mass; dip, 85° NW.	Lenses of quartz and pyrite, carrying gold.
Snowstorm	Fine-grained calcareous sandstone above, quartzitic schist below. Deposit, horizontal; 3 feet thick.	Quartzose mass, impregnated with gold and chloride of silver.
BEAR BUTTE DISTRICT.		
Carter	Mica-schist, with needles of decomposed hornblende. Strike, NW.; dip, 85° W.; ore belt, 100 feet wide.	Lenses of quartz, impregnated with oxide of iron, and carrying gold.
Clermont	Fossiliferous limestone on hanging wall. Vein vertical; strike, NE.; 40 feet wide.	Siliceous hematite, quartz, chalcedony, ocher, and in part earthy limestone, carrying gold and silver.
El Refugio	Quartzite. Strike, NE.; dip, 15° SE. Ore bodies irregular, following stratification; average, 2 feet thick.	Gold- and silver-bearing galena, altered to cerusite; crystals of pyromorphite and wulfenite.
Escondido	Earthy limestone. Deposit: dip, 80° E.; 5 feet wide	Galena, pyrite, and zincblende, carrying silver.
Florence	Ferruginous quartzite (Potsdam?). Horizontal; irregular bodies following stratification; 2½ feet thick.	Pyrolusite, ocher, and siliceous hematite impregnating quartzite, carrying silver.
Hoodoo	Conglomerate of felsite and stratified rocks; explored to a depth of 25 feet.	Free gold in conglomerate.
Keystone	Porphyry, with little quartz; large pink orthoclase crystals; no mica or hornblende; called "porphyritic conglomerate".	Quartz-bearing porphyry, impregnated with auriferous pyrites.
Merritt No. 2	Quartzite (Potsdam). Dip, 35° E.; deposit, 7 feet thick.	Argentiferous galena, limonite, and ocher, with little gold.
Oro Fino	Conglomerate of schist fragments, with ferruginous cement	Free gold in cement.
Rich	Breccia, or conglomerate of porphyry fragments. Dip, S. and E.	Free gold in conglomerate, with ferruginous cement.
Sitting Bull	Quartzite (Potsdam). Dip, 20° SE.; deposit, irregular bodies following stratification.	Galena and siliceous hematite, with carbonate, carrying gold and silver.
Union Hill	Conglomerate or breccia of felsite-porphyry	Country rock, stained with oxide of iron, and carrying gold.
Washington	Quartzite (Potsdam). Deposit, irregular following stratification; horizontal, 1 to 8 feet thick.	Galena, carrying gold and silver.
Yellow Jacket	Foot wall, mica-schist; hanging wall, indistinctly schistose rock. Strike, NW.; dip, 20° SW.; ore body 3 feet thick following the formation.	Cerussite, carrying silver and some gold in quartzose mass.

PENNINGTON COUNTY.

ROCKFORD DISTRICT.		
Alta	Hanging wall greenish decomposed mica-schist. Foot wall dark phyllite. Strike, N.; dip, 45° E.; ore belt, 100 feet wide.	Quartz and altered schist, carrying free gold.
California	Chloritic mica-schist. Strike, N	Decomposed schist and quartz, carrying free gold.
Evangeline	Siliceous schists. Strike, N. and S.; dip, 17° E.; ore belt, 40 feet wide.	Altered country rock, carrying free gold.
CROSS DISTRICT.		
Cross	Mica-schist. Strike, N. 17° W.; dip, 85° E.; ore belt, 100 feet wide.	Actinolite-biotite schist, carrying gold and silver.
Quincy and Little Grace	Siliceous mica-schist. Strike, N. 18° W.; dip, 85° E.; ore belt, 90 feet wide.	Do.
NEWTON FORKS DISTRICT.		
King Solomon	Light-colored phyllites, garnetiferous on foot wall. Strike, N. 15° W.; dip, 80° W.	Quartz and country rock, carrying gold and silver.
Queen Bee	Fine-grained mica-schist. Strike, N. and S.; dip, 45° W.; ore belt 16 feet wide.	Quartz and country rock, carrying free gold.
Royal Bengal Tiger	No specimen; apparently same as above mine. Strike, N. and S.; dip, 85° W.; ore belt 10 feet wide.	Quartz and schists, carrying free gold.

CUSTER COUNTY.

Mine.	Country rock and remarks.	Ore and gangue.
COLE DISTRICT.		
David City Lightning	Mica-schist, with much quartz on foot wall. Strike, N. and S.; dip, 85° W.; ore belt 8 feet wide.	Quartz and schist, carrying free gold.
Knobscott	Mica-schist; dip, N.; ore belt 30 feet wide	Lenticular masses of smoky quartz, carrying free gold.
CUSTER DISTRICT.		
Atlantic	Hanging wall mica-schist; foot wall quartzite. Strike, N. 5° W.; dip, 60° W.	Quartz, carrying free gold.
Grand Junction	Mica-schist. Strike, N. 5° W.; dip, 45° W.; ore belt 70 feet wide.	Auriferous quartz, with little silver, in a schist consisting of radiated aggregations of minute fibers of tremolite.
Hartford	Mica-schist, sometimes garnetiferous. Strike, N. 5° W.; dip, 45° W.; ore belt 100 feet wide.	Quartz and amphibolitic schists, carrying free gold.
Mammoth	Mica-schist. Strike, N. 5° W.; dip, 45° W.; ore belt 100 feet wide.	Quartz and schist, carrying free gold and some silver; garnet occurs with the quartz.
Old Bill	Hanging wall quartzose mica-schist, with garnet and pyrite; foot wall quartzite, with micaceous layers.	Quartz and country, carrying gold and little silver.
Old Charley	Probably Archæan schists; no specimens. Ore belt 300 feet wide.	Quartz masses in fine-grained gneiss, carrying free gold.

GEOLOGICAL SKETCH OF MONTANA.

PHYSICAL DESCRIPTION.—The territory of Montana, lying along the northern boundary of the United States, extends westward from the line of Dakota, at the junction of the Yellowstone and Missouri rivers, theoretically to the extreme crest of the Rocky mountains.

The eastern half, which consists of the valleys of the Yellowstone and Missouri rivers and their immediate tributaries, belongs more properly to the plain country of the northern Missouri valley. This portion of the territory is largely occupied by various Indian reservations, and its mineral wealth has been but little explored.

Of the mountainous western half, the northern portion, adjoining the British boundaries, is also but little known. From the southern boundary of Montana, near the heads of the Yellowstone and the Missouri rivers, the Rocky mountains assume a northwestern trend. The little chartographic knowledge obtained of this region is derived from the records of the Northwest Boundary survey and from the explorations for a route for the Pacific railroad made under the War Department, which give a partial knowledge of certain lines, between which are broad gaps whose topography is comparatively unknown. The Rocky mountains, which in Colorado are a compact series of chains having a general north and south trend, end abruptly in southern Wyoming; but in northwestern Wyoming they are represented by the Wind River, Shoshone, and Big Horn mountains, which take a general northwesterly direction. The Wahsatch system in Utah has also a north and south trend, and is separated from the Rocky Mountain system by the basin of the Colorado river. Through eastern Idaho this chain also loses somewhat of its continuity, and the Rocky Mountain system in Montana is apparently formed by the junction of these two systems of elevation. In general, the mountain regions in western Montana are less elevated than those of Colorado and Utah and abound in broad open valleys, so that in spite of the northern latitude the climate is relatively mild. They are well watered, the hills and valleys support an abundant growth of timber or grass, and in many of the valleys a limited amount of agriculture is possible.

GEOLOGY.—Of the geology of Montana but little is definitely known, the work of the government geological surveys not yet having extended so far north. The surface of the eastern half of the territory is probably largely covered by the Tertiary and Cretaceous formations which are found on the great plains of the south, while along the large streams are broad alluvial valleys, which extend well up to the foot-hills of the mountains and are admirably adapted for agriculture.

As well as can be determined from the scanty material at hand, the geology of the mountainous districts of western Montana is more nearly allied to that of the Wahsatch range than to that of the Rocky mountains of Colorado. Indeed, the Archæan uplift of the Front range of Colorado finds its northern continuation in the Black hills of Dakota on a line with the extreme eastern boundary of Montana. It has already been observed (*a*) that the Wahsatch range forms the geological center of the Cordilleran system, and that between the sedimentary series developed on either side of this central axis there is a great and characteristic difference. The Palæozoic formations, which in Utah and Nevada reach an aggregate thickness of over 30,000 feet, in Colorado have an average of only about 5,000 feet. Over the Great Basin area the Triassic and Cretaceous rocks are entirely wanting, and those developed on the eastern slope of the Rocky mountains, extending in the Wyoming basin as far as the flanks of the Wahsatch, are entirely different from corresponding horizons in western Nevada and California. The heavy limestones of the lower portion of the Palæozoic system are found to thicken as one follows the line of the Wahsatch northward through eastern Idaho. From the older sedimentary beds of Montana, as far as known, no fossils have yet been obtained by which to determine definitely the age of any particular horizon; but the character of specimens of limestone and argillaceous rocks received renders it probable that those developed in the mining regions

a See *Reports of the U. S. Geological Exploration of the Fortieth Parallel.*

of Montana belong to the lower portion of the Palæozoic horizon, the more so as they rest directly on granites or Archæan schists. The only geological data available are furnished by specimens collected in the southern central portion of the western half of the territory, viz, from Lewis and Clarke, Deer Lodge, Jefferson, Madison, and Beaver Head counties. Of the geology of the regions extending north from here to the British line, through Missoula and Choteau counties, but little information is available. That obtained from these counties, which is furnished simply by specimens of country rock brought in by the experts who examined this region, is too meager to afford any ideas of general structure; but there would seem to be an upheaval of Archæan rocks, exposing gneissic formations, on a north and south line through the center of this region. Along this line is also a considerable development of so-called granite, in which the most valuable ore deposits occur. A very large portion of this granite, however, proves to be a diorite of somewhat singular character, possessing certain marked characteristics, which is found from Madison, through Deer Lodge, north to Lewis and Clarke county, and it seems probable that it is an eruptive body of Archæan age, distinct from the true Archæan granite. The specimens which have been microscopically examined were obtained from near the Lexington and Alice mines, at Butte City, and the Deer Lodge lode, in Deer Lodge county; also from Union lode No. 2 and Schafer Mill, in Lewis and Clarke county. It is a crystalline rock, containing both orthoclase and plagioclase feldspars, the latter being predominant, with but little quartz; also a large proportion of basic minerals, among which hornblende, augite, and biotite all occur. This association is the more remarkable, since it seems that these minerals are all original, and the hornblende is not, as would appear at first glance, simply a decomposition product of augite. Under the microscope the former is seen, indeed, to form in many cases the periphery of the augite masses; but it is not fibrous, like the uralitic products of hornblende decomposition, but clear and homogeneous. Hornblende also occurs in distinct individuals; and, moreover, there are distinct intergrowths of biotite and hornblende, both fresh and with the biotite leaves lying parallel to the orthopinacoid of the hornblende. It would seem, therefore, that at a certain period in the growth of the rock the formation of augite may have ceased and the hornblende have formed about the already existing augite particles. The augite is pale, and contains much magnetite in small grains. The biotite changes to a green mineral, which does not seem identical with the ordinary chlorite, and this, in turn, changes into epidote. Most of the biotite is fresh, and titanite, apatite, and magnetite are present. The type described is that from the Union lode. That from Schafer Mill contains more quartz than orthoclase, and some of the quartz is intergrown with orthoclase, so as to make a distinct graphic-granite structure, visible only under the microscope. Both augite and biotite are abundant, but hornblende is relatively rare. The country rock of the Lexington mine, at Butte, has the same general character as that of the type rock. Much of the hornblende is twinned, and intergrowth of biotite is common. The rock of the Alice mine, at Butte, is somewhat coarser grained than the others, and contains a less proportion of basic silicates, augite being entirely absent from the section examined. Mica and hornblende are about equal in quantity, and the hornblende has frequently the outlines of the prism, showing that it can hardly come from the decomposition of augite. The rock from Deer Lodge lode, McClellan's Gulch district, Deer Lodge county, is somewhat different from all of the above. It contains much more quartz and orthoclase, and augite is wanting, although hornblende and biotite are similarly intergrown as in the type rock. It also contains apatite, a little magnetite, and a few pale crystals of zircon, but no titanite. A more detailed study of this interesting rock than it was possible to make by the aid of the few specimens collected by the census experts would be necessary in order to definitely determine its character. In the subjoined tables it has been provisionally called "diorite-granite", to distinguish it from the normal type of granite which occurs in the same district, but whose structural relations to it are as yet unknown.

Of rocks which could be definitely determined as belonging to the Secondary eruptive series but few specimens were brought in. There can, however, be no doubt that they are of frequent occurrence in the territory, and it seems probable that to this type may belong the so-called granites which overlie the contact deposits in limestone of the Bannack district. But little reliance can, unfortunately, be placed on the nomenclature given by miners to the rocks they find associated with their ores, since they, too, often pride themselves on having distinctive names of their own, quite independent of any scientific usage. The so-called porphyries reported from Montana mines have proved, where specimens have been sent in, to be more or less altered granites or gneisses. Of Tertiary eruptive rocks such great flows exist in Idaho on the south and west, and also in the Yellowstone park, that it is probable many may occur in the territory. The only definitely known occurrence is the rhyolite, which breaks through the diorite-granite at Butte City.

ORE DEPOSITS.—The ores of Montana are mostly of gold, silver, and copper, either separately or in combination with two or more of these metals. Argentiferous lead ores also occur, but in far smaller proportion than in Colorado, and are seldom free from other base metals. These ores are found either in veins in the crystalline rocks or as irregular deposits in sedimentary rocks, sometimes crossing the strata, but generally more or less coincident with bedding-planes. Of the deposits in crystalline rocks the majority of the best known, and those whose bodies are strong and well defined, are of the class of metamorphic veins, *i. e.*, their vein material is a portion of the country rock, more or less altered along certain planes, in which silica, calcite, and metallic minerals have replaced portions or all of the original constituents. In these deposits there is, as a rule, no definite limit or wall, or, at the most, on one side

only; and it is evident that there was no pre-existent open fissure, as is theoretically supposed to have been the antecedent condition of the "true fissure vein". It may also be said that, as far as our present knowledge goes, there is no valid reason for supposing that such deposits are any less permanent or rich than those which may show evidence of having been deposited in a pre-existing open fissure.

In some cases gold-bearing ores seem to be simply impregnations of the gneissic country rock with auriferous pyrites, and probably occur in lenticular interlaminated quartz masses, such as on a very much larger scale constitute the so-called gold veins of the Black hills of Dakota. Deposits in limestone seem to be here, as elsewhere, very irregular in form, but tend to follow bedding or contact planes and cross-joints which have yielded more easy access to metallic solutions. Owing to the superior thickness of the Palæozoic formations in this region the vertical range of the deposits is probably much greater than in Colorado.

A considerable proportion of the ores are auriferous pyrites and quartz, sufficiently oxidized to mill freely; but the greater value and bulk are those of more complex composition, which require to be smelted. These have two characteristics which distinguish them from the ores of Colorado: first, a usual presence of copper, rather than of lead, as a silver-carrier, and of manganese, instead of iron, in that part of the ore which goes into the slags in smelting. Chalcocite, or copper glance, is one of the most common minerals, and oxide of manganese, passing into carbonate below the water level, is exceptionally frequent. No data are at hand for making even an approximately complete list of the minerals which occur in the territory.

PLACER DEPOSITS.—Until within a comparatively few years the main precious-metal production of Montana has been derived from its placer deposits, which are exceptionally rich. Estimates place their total yield at over $50,000,000, but it is impossible to say how close an approximation to the truth these estimates may be, since the grounds on which they are based are not given, and the determination of the yield of placer mines is the most difficult task the mineral statistician has to undertake. The first deposits were discovered in 1861 in the Pioneer district, on Gold creek, a branch of Deer Lodge river, in the county of the same name. For many years the production of the placer mines was very large; and a great many are worked at the present day, although their production has somewhat fallen off by the working out of the exceptionally rich deposits. Hydraulic mining is carried on to a very considerable extent, and many Chinese miners find ample remuneration in working over abandoned gulch mines. Owing to an unfortunate combination of circumstances the census data were collected very late in the season, when the placer mines were mostly abandoned for the winter; and the data in regard to these deposits are, consequently, very incomplete. The deposits which are worked seem to have been found mostly in rather open valleys, but comparatively high up in the mountains, and consist consequently of rather coarse gravel. For deposits of this character they are exceptionally thick, varying according to data from 5 to 65 feet; and in many cases actual bed-rock had not been reached, but only a clayey seam or false bed-rock, below which the gravel is said to be barren.

From many of the deposits fossil shells and petrified bones and tusks are said to have been obtained. No specimens, however, have been sent in. It seems likely, therefore, that these deposits are, as a rule, older than the ordinary river gravels, and may date back to the flood period following the Glacial epoch. Placer deposits are known to be worked in Beaver Head, Madison, Gallatin, Meagher, Jefferson, Deer Lodge, Lewis and Clarke, and Missoula counties, the most productive of which have been those of Alder gulch, a branch of the Stinking Water, at the head of the Jefferson river, in Madison county. Next to these are those of Deer Lodge county, the most important of which is the Pioneer district, and several in the neighborhood of Butte City which are tributary to the Deer Lodge river, the Henderson district, near Flint creek, and the McClellan Gulch district, at the head of the Big Blackfoot river.

In Lewis and Clarke county the Last Chance district, near Helena, has been a large producer; and important deposits have been worked on both sides of the Missouri river, both in this and in Meagher county, as also on the east slope of the Big Belt mountains of the latter county. Placers have also been worked in Gallatin county north of the National park, along the tributaries of the Yellowstone river. In Beaver Head county the placers near Bannack have a bed-rock of conglomerate with lime cement, containing shells and large bones, which must, it seems, have as early an origin as the Glacial epoch. The gold is coarse shot gold, with a relatively large proportion of nuggets as large as walnuts; and that derived from the Montana placers, in general, has a higher average grade of fineness than that of other territories.

DEER LODGE COUNTY (SILVER BOW COUNTY).

The most important mining district in the state is Summit valley, near Butte City, which, since the legislative action of February, 1881, is now included in the new county of Silver Bow. The ore deposits of this district all occur either in true granite or in the diorite-granite already described. The majority of the veins from which data are available have an east and west strike and dip at a high angle to the south. Besides the granite country rock, rhyolite occurs, which forms the so-called butte from which the town derives its name, ramifications from which body, it is suspected, may be found in the neighborhood of some of the important mines. The veins belong certainly to the type of metamorphic veins, *i. e.*, although the richer part of the ore is often found in a gangue of almost exclusively siliceous material and with a fairly defined wall on one side, on the other there is no definite

limit, but the country rock is found to yield pay material for a varying distance from the main ore body, and the limit to which the impregnation has extended is, consequently, not determined, since only that which it would pay to work is extracted. The most important mines of the district are the Alice, Lexington, Belle, Gagnon, and North Star. Ores rich in copper and silver, and carrying an exceptionally large proportion of manganese minerals, are the prevailing type.

The Flint Creek district, near Phillipsburg, to the northeast of Butte City, has silver-bearing ores carrying zinc, copper, and lead minerals in a limestone generally white and crystalline. In the case of the Salmon mine granite is reported as occurring on the hanging wall of the vein, but as no specimens were returned it seems questionable whether it may not be a crystalline porphyry.

In the McClellan Gulch district, at the head of the Big Blackfoot river, auriferous quartz is found in a rock resembling the diorite-granite of Butte City.

LEWIS AND CLARKE COUNTY.

The principal mines of Lewis and Clarke county appear to be near Helena at its southern extremity and along the heads of Silver creek a short distance north. At Helena they are mainly gold-bearing veins in granite. In the Silver Creek region they are also gold-bearing ores, containing a little silver, but occur in slates and slaty limestones; and although standing at a high angle, and called fissure veins, it would seem that in some cases at least they are more probably segregations of quartz and mineral in bodies lying parallel with the formation.

JEFFERSON COUNTY.

In Jefferson county the ores carry both gold and silver in varying proportions, and the mines occur in various districts on either slope of the mountains lying west of the Missouri river. The ores are comparatively free from base metals, and occur in felsite-porphyry and other undetermined eruptive rocks, and in limestones parallel with the stratification-planes.

MADISON COUNTY.

In the northeast portion of Madison county, near the Jefferson river, are the Silver Star districts, whose ores occur mainly in gneiss, and are gold-bearing, with a slight admixture in some cases of lead and copper ores. The Broadway mine is reported to be a bedded deposit at the contact of limestone with granite.

In the Mineral Hill district, at the head of Willow creek, north of Virginia City, galena and quartz, carrying both gold and silver, are found in gneiss; and in the Red Bluff and Hot Springs region, near the Madison river, are ores of galena and pyrite, also mainly in gneiss, carrying both gold and silver.

BEAVER HEAD COUNTY.

In Beaver Head county, near Bannack City, auriferous pyrite in quartz, sometimes associated with galena, is found in limestone, with a hanging wall of so-called granite. The strike of this formation seems to be uniformly to the northeast, with a shallow dip of from 15° to 20° to the south and southeast. As already stated, it seems probable that the so-called granite is a quartz-porphyry or diorite. Slates and limestones can be traced northward from Bannack, through Argenta, to Glendale, near Big Hole river. At first they preserve the westerly dip observed near Bannack, which gradually steepens, and becomes vertical some 15 miles north of Argenta. The formation from here to Glendale dips to the eastward. Along Trapper creek, which flows into the Big Hole from the west, are easterly-dipping slates, apparently underlying the limestone which is found at Glendale. At its head is a cliff about 1,000 feet in height of blue-gray limestone beds, underlaid by black bituminous shale, dipping 16° to the westward; half-way up the cliff are the deposits of the Hecla Consolidated mines, which are masses of argentiferous galena, zincblende, copper, and iron pyrite, and their oxidation products, occurring on the stratification-planes of the limestone at different horizons. These ores are smelted to a lead bullion and a copper matte carrying silver. Big Hole river, some 8 or 10 miles higher up, runs through a cañon cut in gneiss, and at Dewey's flat, above the cañon, abundant gold-bearing quartz veins in gneiss are said to occur.

DEER LODGE COUNTY. (a)

Mine.	Country rock and vein.	Ore and gangue.
SUMMIT VALLEY DISTRICT.		
Alice	Diorite-granite, rich in plagioclase, with some augite. Vein: strike, NE.; dip, 65° NW.; 35 feet wide.	Native silver, and sulphide, with carbonate of manganese, quartz, and pyrite, carrying gold and silver. Gangue: altered country.
Anaconda	Granite (?). Vein: strike, E. and W.; dip, 75°; 8 feet wide.	Chloride of silver, malachite, azurite, chalcocite. Gangue: siliceous, may be altered porphyry.
Anglo-Saxon	Granite. Vein: dip, 47° S.; 2½ to 5 feet wide	Cerussite, carbonate of manganese, and sulphide of silver in quartz; yellow stains of antimony; carries silver and little gold. Gangue: decomposed granite.
Anselmo	Granite, containing pyrites. Vein: strike, E. and W.; dip, 7° S.; 2 to 5 feet wide.	Native silver; argentite, galena, pyrite; traces of manganese, copper, and gold in quartz. Gangue: decomposed granite.
Belle	Diorite-granite. Vein vertical; strike, E. and W.	Massive chalcopyrite, with pyrite, bornite, freibergite (?), and native silver, with but little quartz. Gangue: clay, with rounded granite pebbles.
Cleat Grit	True granite. Vein: strike, NW.; dip, 70° SW.; width, 15 to 17 feet (2 feet productive).	Cellular quartz, containing sulphuret of silver; little gold.
Colusa	Granite (?). No specimens. Vein: strike, NW.; dip, 70°; 14 feet wide.	Chalcocite, massive and impregnating the granite. Gangue and horse material; decomposed quartz-bearing granular rock.
Cora	Granite (?). No specimens. Vein vertical; strike, E. and W.; 26 feet wide, including horse of porphyry.	No specimens. "Copper, lead, a little zinc and silver, and antimony."
Gagnon	Granite. No specimens. No distinct walls. Vein: strike, E.; dip, 80° S.; width, 150 feet (8 feet pay).	Chalcocite, silver-bearing. Gangue: mainly quartz, with pyrite.
High Ore	Decomposed granite. Vein: strike, E. and W.; dip, 45° S.; 12 to 16 feet wide.	Chloride of silver (?) in cellular quartz; little gold.
Late Acquisition	Diorite-granite. Vein: strike, E. and W.; dip, 75° S.; 5 feet wide.	Pyrite and chalcocite in quartz; galena and chlorides said to occur; little gold. Gangue: decomposed country rock.
Lexington	Diorite-granite. Vein: strike, E. and W.; dip, 80° S.; 8 feet wide.	Galena and cerussite, with rhodonite; silver and gold bearing.
Morning Star	Granite. Vein vertical; strike, E. and W.	Auriferous pyrite; native silver and sulphuret in quarts. Gangue: altered granite.
Mountain	Granite. No specimen. Vein: strike, NW. and SE.; dip, 75° S.; 8 feet thick.	Copper. No specimens.
National	Decomposed granite. Vein: strike, E. and W.; dip, 80° S.; 20 feet wide.	Chalcocite and pyrite, carrying silver.
Nettie	Granite. Vein: strike, E. and W.; dip, 70° S.; 5½ feet wide	Pallomelane and horn-silver.
North Star	No specimens. Called granite-porphyry, may be rhyolite. Vein: strike, E. and W.; dip, vertical; 50 feet wide.	Chloride, black sulphuret, and native silver. No specimens.
Shakspeare	Granite (diorite?). Vein: dip, 90°; 20 to 40 wide; foot wall not found.	Largely chalcocite, carrying little silver.
Shonbar	"Soft granite." No specimens. Vein: strike, E. and W.; dip, 70° S.; 12 feet wide.	"Black manganese," carrying silver and little gold. No specimens.
Silver Bow Mining Company (13 mines reported in one schedule).	Granite and syenite (?). No specimens. Veins: strike, about E. and W.; dip, from 45° to 90°.	Ores carrying galena, cerussite, pyrite, chalcopyrite, and sulphurets. No specimens. Veins said to be inclosed in porphyry, probably decomposed granite (diorite).
Springfield	"Hard granite." No specimens. Vein: dip, 70° S.; pay-streak, 4 feet wide on foot wall.	"Sulphurets of silver and iron." No specimens.
Star West	Hanging wall like granite. Foot wall diorite (?). Vein: strike, ? dip, 30° S.	Freibergite and pyrite, with manganese mineral.
Stevens	Altered syenite (diorite?). Vein: strike, E. and W.; dip, 60° S.; 4 feet wide.	Cellular quartz stained yellow, carrying gold and silver. No mineral visible.
Volunteer	"Soft granite." Veins (2) 16 feet apart; strike, E. and W.; dip, 45° S.; one 3 feet, the other 8 to 15 feet wide, the former the richer.	Massive zincblende and freibergite, said to contain also horn-silver and galena.
Wabash	Granite. No specimens. Vein: strike, E. and W.; dip, "10°" (probably 80°) N.; 100 feet wide; pay-streak 2 to 6 feet.	Cellular quartz with yellowish green coating, said to contain gold and chloride of silver. Gangue: a crumbling mass of quartz and feldspar stained reddish yellow, probably altered country.
INDEPENDENCE DISTRICT.		
Mountain Boy	Granite. Vein: strike, about E. and W.; dip, 70° S.; 2 feet wide.	Quartz, impregnated with galena; pyrite, rhodochrosite, with native silver on joint-planes. Gangue: decomposed country rock.
Self-rising	"Porphyry" (?). No specimens. Vein: strike, E. and W.; dip, vertical; 3 to 7 feet wide.	Black oxide of manganese, with gold, silver, and copper. No specimens.
FLINT CREEK DISTRICT.		
Algonquin	White granular limestone (dolomitic?) near granite. Deposit: strike, N. 20° E.; dip, 45° E., in irregular bodies.	Galena, blende, gray copper, etc., in quarts. Oxide of manganese and pyrite also occur; silver bearing.
Salmon	Granite (?) hanging wall. No specimen. Limestone foot wall. Deposit: strike, N. 20 E.; dip, 45° E.	Quarts, with zincblende and copper stains, carrying silver.
Speckled Trout	Gray crystalline limestone, fine-grained on hanging wall, coarser-grained on foot wall. Vein: strike, NE.; dip, 80° SE.; 2 feet wide.	Mainly crystalline zincblende and argentiferous galena; said to carry ruby silver.
Rope	Fine-grained yellowish limestone; ore deposit in bedded masses; strike, E. and W.; dip, 32°; 4 to 9 feet thick.	Quarts, impregnated with black sulphurets of silver and carbonate of copper.
Scratch Awl	Limestone, white and crystalline, on the north wall; thinly bedded and slaty on the south wall. Vein: strike, E. 6° S.; dip, vertical; 2 feet wide.	Stained quarts, with oxides of manganese and copper, carrying silver.
M'CLELLAN'S GULCH DISTRICT.		
Deer Lodge	Diorite-granite. Vein: strike, N. 20 E.; dip, 20° W.; 1 to 2 feet wide,	Iron-stained quarts.
McClellan's Gulch lode	Diorite-granite. Vein: strike, NE.; dip, 20° S. E	Iron-stained quarts.

a In February, 1881, a portion of Deer Lodge county, including the Summit Valley district, was set off into a separate county, called Silver Bow.

LEWIS AND CLARKE COUNTY.

Mine.	Country rock and vein.	Ore and gangue.
SILVER CREEK DISTRICT.		
Albion	Dark slate. Vein: strike, E. 8½° N.; dip, 70° N.; 18 inches to 11 feet thick.	Quartz, with oxides of iron and manganese, little lead and copper, carrying gold and little silver.
Penobscot, Snowdrift, and Courage.	Tough greenish slate, with imperfect bedding; small quartz veins. Vein: strike, E. and W.; dip, 70° N.; 4 to 18 feet wide.	Quartz, with oxides of iron and manganese; stibnite in pockets; carries gold and trace of silver.
Belmont	Slate at surface. No specimens. Normal granite in depth. Vein: strike, E. and W.; dip, S.; average width, 6 feet, with two branches.	Quartz, with some calcite, carrying gold and silver.
STEMPLE DISTRICT.		
Hickey and Bluebird	Dark compact slate, with imperfect bedding; ore bodies; strike, E. and W.; dip, 80° S.	Mixture of quartz and feldspar, carrying gold; gangue of fine, compact limestone in center of ore body in depth.
Mount Pleasant	Slaty limestone. Deposit: strike, E. and W.; dip, 80° S.; width, 5 feet.	Ore deposit like the former.
Sandford	Same character as Hickey and Bluebird, of which it is a continuation.	
Whip-poor-will	Slaty limestone. Vein: strike, E. and W.; dip, 75° N.; 3 feet wide.	Iron-stained quartz.
OTTAWA DISTRICT.		
Drumlommond	Syenitic granite, with a little quartz. Vein: strike, E. and W.; dip, 70° S.; 60 feet wide (40 feet long).	Mixture of quartz and feldspar, stained with azurite and iron oxide.
OWYHEE DISTRICT.		
Union lode No. 2	Diorite-granite, with biotite, hornblende, and augite. Vein: strike?; dip, 30° N.; 3 feet wide.	White gold-bearing quartz.

JEFFERSON COUNTY.

CATARACT DISTRICT.		
Boulder	Decomposed porphyry. Vein: strike, N. 70 W.; dip, 85° NE.; 7½ feet wide.	Iron-stained quartz, carrying gold.
Mantle	Syenite (?) containing a little quartz. Vein: strike, ENE.; dip, vertical; 4 feet wide.	Gold-bearing quartz, with pyrite; little silver.
CEDAR PLAINS DISTRICT.		
Keating	White homogeneous felsite, impregnated with pyrites. Vein: strike, N. and S.; dip, 85° W.; 3 feet wide.	Massive pyrite, carrying gold and silver.
ELKHORN DISTRICT.		
Alta	Compact felsitic porphyry. Vein: strike, NE.; dip, 60° NW.; 8 to 10 feet wide.	Quartz, carrying galena and pyrite, silver, and a little gold.
A. M. Holter	Limestone, thin bedded and compact on hanging wall; granular, resembling a sandstone on foot wall; ore body, dip 45° to the north with the stratification.	Quartz, with argentiferous galena, some native and horn-silver.
MOUNTAIN DISTRICT.		
Little Giant	Greenish eruptive rock; undeterminable. Vein: strike, E. and W.; dip, 60° S.; 4 to 6 feet wide.	Iron-stained mass, quartz and clay carrying gold.
DISTRICT NOT ORGANIZED.		
Bonanza Chief	No specimen. "Quartzose rock," "bedded mass in granite." Dip, 20° NE.	Iron-stained siliceous matter, containing gold and traces of silver.
SILVER STAR DISTRICT.		
Aurora Borealis	Fine-grained gneiss. Vein: strike, E. and W.; dip, 45° S.; 2 feet wide.	Gold-bearing quartz with galena; little carbonate of copper and iron oxide.
Broadway	Hanging wall dark impure limestone; foot wall granite. Deposit: strike, NW. and SE.; dip, 28° S.; thickness, 15 feet.	Yellow ferruginous jasper, with spots of hematite, chalcedony, and calcite in the fissures; carries gold.
Grasshopper and Cricket	Syenite(?), probably gneiss. No specimen. Vein: strike, E. and W.; dip, 60° S.; 6 to 6 inches wide.	Iron-stained gold-bearing quartz.
Grubstake	Even-grained gneiss. Vein: strike, NW.; dip, 45° NE.; 2 feet wide.	Decomposed yellow rock, probably gneiss carrying silver.

MADISON COUNTY.

HOT SPRINGS AND RED BLUFF DISTRICTS.		
Boss	Gneiss. Vein: strike, NW.; dip, 45° E.; 2 feet wide	Crumbling, stratified rock, iron-stained, and carrying gold. Altered country.
Cordwainer	Fine-grained biotite-gneiss. Vein: strike, NW.; dip, 50° NE.; 2½ feet wide.	Crumbling, iron-stained gneiss, carrying gold; little copper.
Red Bluff	Gneiss. Vein: strike, E. and W.; dip, 41° N.; 3 to 6 feet wide	At surface red or blue jasper, with some pyrite and galena, carrying gold and silver. Below water level solid mass of pyrite and galena, with little quartz.
Red Chief	Granite (?). No specimens. Vein: dip, 48° NE.; 4 feet wide	Iron-stained quartz, carrying gold and silver.
MINERAL HILL DISTRICT.		
White Pine	Gneiss, with rhombic pyroxene. Vein: strike, E. and W.; dip, 45° S.; 18 inches wide.	Massive quartz, with some galena, carrying gold and silver.

BEAVER HEAD COUNTY.

Mine.	Country rock and vein.	Ore and gangue.
BANNACK DISTRICT.		
Dakota and Blue Grass	Hanging wall granite; foot wall limestone. No specimens. Deposit: strike, NE.; dip, 15° SE.; 8 feet thick.	Quartz, pyrite, and siliceous oxide of iron, carrying gold.
Excelsior	Hanging wall granite (?) and trap; foot wall limestone. No specimens. Deposit: strike, NW.; dip, 20° SE.; 8 feet thick.	Iron-stained quartz and pyrite.
French	Hanging wall granite (?); foot wall limestone. No specimens. Deposit: strike, E. and W.; dip, 15° S.; 15 to 40 feet thick.	Siliceous iron, with pyrite, carrying gold.
Golden Leaf	Same as French. Deposit: 10 to 30 feet; dip, 15° S.; strike, NE. and SW.; 10 to 50 feet thick.	Oxide of iron, free gold, argentiferous galena.
Springfield	Hanging wall granite (?); foot wall limestone. No specimens. Strike, NE.; dip, 15° S.; 5 feet thick.	Auriferous iron-stained quartz.
Washington	Like the preceding.	
BALD MOUNTAIN DISTRICT.		
Elkhorn	Granite. No specimens. Vein: strike, NE. and SW.; dip, 88° N.	"Zincblende, black copper, gray copper, chloride, and native silver." No specimens.
TRAPPER DISTRICT.		
Hecla	Dolomite, blue and gray. Ore deposit follows the stratification-planes. Strike, N.; dip, 16° W.; 2½ feet thick. Several bodies.	Contains galena, cerussite, calamine, and copper minerals. Gangue: white crystalline limestone.
Keokuk	Limestone, siliceous on hanging wall, crystalline on foot wall. Ore deposit following the stratification-planes. Dip, 35° SW.	Oxides, carbonates, and sulphurets of silver, lead, and copper. No specimens.

GEOLOGICAL SKETCH OF NEW MEXICO.

The territory of New Mexico, adjoining Colorado on the south, has a somewhat larger area, and is included between the one hundred and third degree of longitude west of Greenwich and the thirty-second west of Washington, and extends from the thirty-seventh degree of north latitude to the boundary of Mexico, which, except in the southwestern corner, is formed by the thirty-second degree of north latitude. Its climate is even drier than that of Colorado, which may be due to the fact that it has no concentrated high mountain mass to act as a condenser to the moisture-laden winds coming from the southwest. The mountain systems of Colorado end abruptly near its northern border, the Colorado range continuing with a gradually decreasing elevation as far south as Santa Fé, while the San Juan mountains, to the west of San Luis park, sink beneath the Cretaceous plains almost before the boundary is reached. Its surface is made up of an irregular series of detached mountain chains, stretching across the middle of the territory in a southwesterly direction, with a mesa country, belonging to the Colorado plateau region on the northwest, and broad arid plains, a continuation of those in northern Texas, stretching to the eastward. Across the middle of this area from north to south runs the Rio Grande river, whose valley presents many analogies with that of the famous Nile valley of Egypt. Its climate is warm and equable, and its alluvial soil, which occupies a comparatively narrow strip on either side of the river, in general not more than 2 miles in width, is of exceptional fertility. Like the Nile, it is subject to periodical overflows, and the area of its arable land can probably be increased by a more perfect system of irrigation than has been carried on by the Mexican population which at present occupies it. With the exception of this valley, there is little, if any, land in the territory which can be considered available for agriculture, not from any want of fertility of soil, but from the absence of water for irrigating purposes. The main wealth of the territory lies, therefore, in its grazing lands and its mineral resources.

Our geographical knowledge of this area is as yet extremely imperfect, being derived only from the meander lines made in early years by various government expeditions in exploring routes for a Pacific railroad and from detached maps of portions of the central and northern regions made by the explorations west of the 100th meridian under Lieutenant Wheeler.

In regard to its geology our information is equally fragmentary, being derived from the notes made by Professors Jules Marcou and J. S. Newberry, who accompanied the earlier railroad explorations, and of Messrs. G. K. Gilbert, E. E. Howell, and Professor J. J. Stevenson, who accompanied different parties of the Wheeler exploration. The census material with regard to this territory is also exceptionally incomplete, owing to the fact that Colonel Charles Potter, to whom was intrusted the duty of visiting and reporting on its various mining districts, was treacherously waylaid and killed by a party of seven Mexican robbers while in the discharge of this duty, and while his work, though nearly completed in the field, still needed his personal supervision to put it into an intelligible form.

GENERAL GEOLOGY.—The Archæan island which stretched through the state of Colorado from its northern to its southern boundary ended abruptly in New Mexico, its continuation to the southward being marked only by a series of more or less submerged reefs in the ocean, which covered this area until the close of the Cretaceous period. Up to this time, therefore, the waters of the ocean had free access to the Colorado plateau region, and at the present day the coal-bearing or Cretaceous rocks are known to extend over a great portion of the territory. Owing to the limited rainfall, the valleys and mountain slopes are much more heavily covered by Quaternary *débris* than those

of Colorado, and the character of the underlying rocks is therefore more difficult to recognize. The Cretaceous formations are, however, known to extend from the plain country westward to the Rio Grande valley, and in the northwestern portion of the territory to connect with the Colorado plateau region, while they still form the surface rock over a very considerable area. In the latter region they are known to extend beyond its western boundaries, but in the mountain region, in the southwestern portion of the territory, they have either been entirely eroded off, or else, owing to some dynamic movement later than the Palæozoic period, as yet unproved, they were not deposited. Of eruptive rocks there is considerable development of quartz-porphyries and other Secondary rocks, especially in the southwestern portion of the territory; but no sufficient study has been made of them to determine definitely their age or relation to the Palæozoic beds in connection with which they are found. The only known Tertiary beds are those near San Ildefonso, which are supposed to be of Pliocene age. As yet, therefore, there is no record to determine the period at which the Tertiary eruptive rocks, which are so largely developed in the territory, were first poured out on the surface. Of these, as Mr. Gilbert shows, an immense crescent-shaped area extends through eastern Arizona and western New Mexico to the volcanic group of the San Francisco mountain at its northwestern point, and to that of Mount Taylor, in New Mexico, at its northeastern. They also cover considerable isolated areas to the east of the Rio Grande. That eruptive activity has continued until comparatively recent times is proved by the existence of numerous actual craters and cinder-cones in a region 35 to 40 miles southwest of Mount Taylor, from which streams of lava flowed out in every direction, extending at least 50 miles to the westward and to an unknown distance to the eastward. These recent lava flows are, according to Mr. Gilbert, all basaltic, while the mass of Mount Taylor consists of an older eruptive rock, described by him as something between a basalt and trachyte, and which, from analogy with other regions, may be supposed to be either andesite or a still earlier porphyrite. Professor Stevenson also describes extinct craters as existing to the east of Santa Fé near the Turkey mountains and flows of basaltic lavas filling the cañon of the Mora river. The northwestern part of the territory, therefore, which, from the Nacimiento range westward, belongs to the mesa region, and south of the Carboniferous anticlinal of the Zuñi range consists a broad belt of lava extending to the plains of San Augustin, is covered by rocks of too recent age to afford much promise to the prospector. It is in the mountain groups stretching across the territory to the southeast of this region that the principal developments have thus far been made. Among these Mr. Gilbert distinguishes two prevailing trends—a northwesterly and a north-and-south direction. The former, which is more common in the southwestern portion of the territory, he considers as belonging to a portion of the Basin range system, which stretches through Arizona in the direction of the Sierra Nevada; the latter he connects with the Colorado system. In these different regions the rocks thus far recognized are either Archæan or Palæozoic. Granite and gneiss are often found as a nucleus, and here, as elsewhere, are distinctly unconformable with the later beds of the Palæozoic formations, which consist of quartzites, sandstones, limestones, and shales. Fossil evidence has been found of the existence of the Cincinnati group of the Silurian, the Waverly or sub-Carboniferous, and the characteristic Carboniferous limestones of the Rocky Mountain region. Of Mesozoic formations the Trias is recognized in the northern portion, and is described by Professor Stevenson as being extremely thin or at times entirely wanting along the edge of the mountains northeast of Santa Fé. The aggregate thickness of the Cretaceous rocks, which consist, as elsewhere, of sandstones and shales, is given by Professor Stevenson at 2,000 feet. Mr. Gilbert states that coal is found throughout this entire formation, but only that of the middle is of economic importance. Professor Stevenson, on the other hand, makes the Galisteo beds, which have been practically developed in the northeastern part of the territory, belong to the Laramie group, or extreme upper member of the Cretaceous. Of the age of the coal-beds which have recently been developed in the neighborhood of the Rio Grande valley in the central and southern portion of the territory no information is available. In the succeeding description will be given the few facts it has been possible to obtain with regard to the geology of the mining regions thus far developed, following as far as possible the division by counties.

COLFAX COUNTY.

The western portion of Colfax county includes the southern end of the Rocky mountains, locally called the Taos and Baldy ranges, which consist of a nucleus of Archæan, overlaid by Carboniferous limestone and flanked by Mesozoic beds. Throughout the region there is a considerable development of eruptive rocks classed as trachytic, and on the adjoining plains, on either side, are recent flows of basalt. Partially included in the range is the longitudinal Moreno valley, whose Quaternary deposits are said to constitute rich gold placers. Besides the placers, gold veins are said to have been developed, but no working mines are reported. Specimens of gray copper ore, associated with coal, have been brought in from points along the eastern foot-hills of the mountains. Their geological position is not known The matrix is a sandstone resembling those of the Cretaceous formation, and it may be that they occur in connection with the singular longitudinal dike mapped by Professor Stevenson. Galena and considerable placer deposits occur in Taos county, adjoining Colfax on the west.

SANTA FÉ COUNTY.

The oldest mines of the territory, said to have been worked by the Spaniards when they first came here, over three centuries ago, are probably in Santa Fé county.

The Los Cerillos district embraces the Los Cerillos mountains north of the Galisteo river, and the Ortiz mountains to the south. In the former an eruptive rock, probably rhyolite or trachyte, breaks through the Cretaceous strata. In this are found irregular, thin deposits of galena and the celebrated turquoise mines, which have been worked for years both by Mexicans and Indians. This mineral occurs apparently as an impregnation along the cleavage faces of the country rock. Along the Ortiz mountains and the Placer mountains to the south are valuable placer deposits, which in places have been penetrated 60 feet without reaching bed-rock. But little is known of their extent or character, and, owing to the want of water, they have thus far been but little developed. The Placer mountains consist of Archæan rocks overlaid by Carboniferous limestone. Veins of auriferous pyrites are said to occur in the Archæan; also magnetic iron ore. In the limestones are deposits following the stratification and occurring in connection with what is called porphyry, which contain both auriferous pyrites and sulphurets of copper, more or less oxidized, carrying silver.

In Bernalillo county the Sandia mountains, which rise abruptly to the east of Rio Grande valley, are formed, according to Marcou, of Carboniferous strata dipping to the eastward, and have been apparently lifted to their present position by a fault. On their slopes occur also rich placer deposits. West of the Rio Grande copper has been obtained from the sandstones of the Trias in the neighborhood of Abiquiu. The ores are found as carbonates and oxides, replacing fossil plants.

SOCORRO COUNTY.

In the Socorro mountains, lying opposite the town of Socorro, on the Rio Grande river, according to Professor B. Silliman, (a) are several large veins of heavy spar running in a northeast and southwest direction and dipping 40° to the northwest, carrying chloride of silver and vanadium-bearing mimetite. The Magdalena mountains, 30 miles west of this, consist, according to the same authority, of slates, limestones, and quartzites, resting on gneiss and traversed by porphyritic eruptions. The Juniata lode is described as a vertical deposit of lead carbonates between porphyry and slates reaching a maximum thickness of 65 feet, but of low grade in silver. Galena and zincblende, with calamine and anglesite, are also found in the same deposit.

In the Oscuro mountains, to the east of the Rio Grande, are deposits of copper glance, azurite, and malachite, carrying a little silver and gold in a siliceous conglomerate. These ores, like those already mentioned, are associated with remains of fossil wood and various plants, and are said to carry from 10 to 60 per cent. of copper. This conglomerate, because of the resemblance of the deposits to those of Russia, which occur at this horizon, is regarded as of Permian age by Professor Silliman. The reason for such determination seems rather inadequate, in view of the fact that the Permian group has not yet been definitely recognized in the Rocky mountain system, to which these deposits belong, and that the beds in which similar deposits have been found in Colorado and New Mexico have hitherto been determined as Triassic.

The Negretta or Black range extends across Socorro county into Grant county, adjoining, and is apparently connected with the Miembres range. It is so called because of the dark-colored firs which cover it. According to Professor Silliman, this range is intersected by powerful lodes carrying gold, silver, copper, zinc, and lead, but no indication is given with regard to the character of the country rock, except that porphyry is mentioned as inclosing one vein. In the western portion of the county, at the head of the San Francisco river, is the Mogollon district, in which islands of Archæan granite, with Palæozoic rocks resting on them, occur on the southern border of the lava area already mentioned; and in the limestones of the latter are rich deposits of copper, in some cases carrying both gold and silver. No returns from individual mines are at hand.

LINCOLN COUNTY.

In Lincoln county, to the east of Socorro county, about 125 miles from the Rio Grande valley, is the White Oaks district, in a mountain group generally known as the Sierra Blanca. Gold ores are reported as discovered in this district, but no reliable data are at hand as regards either their value or the geology of the district.

DOÑA AÑA COUNTY.

In the Organ mountains, to the east of the Rio Grande, 15 miles from Las Cruces, argentiferous galena ores are reported. Near Hillsboro', on the west of the Rio Grande, are placer deposits, and gold veins are said to have been discovered.

The most important mining district of the county is Lake valley, which is on the eastern slope of the Miembres mountains. This range, according to Mr. Gilbert, has a core of Palæozoic limestone, with lava on the western slope. The ore bodies occur following the bedding-planes of limestone beds, which dip to the eastward. The foot wall is a heavy-bedded bluish-gray limestone, above which are thinly-bedded shaly limestones, carrying

a Trans. A. I. M. E., Feb., 1882.

fossils of the Waverly group. The ore consists of argentiferous galena and cerussite, with chlorides and chloro-bromides of silver in a gangue of red and brown hematite, with some oxide of manganese, and silica in the form of chert. Professor Silliman reports also the occurrence of vanadinite. The deposits apparently resemble in their manner of occurrence those of Leadville. Irregular masses and dikes of eruptive rocks are reported also as occurring in the region, but their lithological character and direct relation to the ore deposits is not yet definitely known.

GRANT COUNTY.

Grant county has been the principal mineral producer of the territory, its most important mines being located within an area of which Silver City and Fort Bayard form the center. In the Miembres district, on the west slope of the Miembres mountains, to the east of Silver City, are argentiferous lead ores in limestones of Palæozoic age. The limestones are fossiliferous, and dip to the eastward; but it is not known whether they correspond to those of Lake valley on the east or to those in the neighborhood of Silver City on the west. The deposits follow the bedding, having a foot wall of limestone, with shale on the hanging wall. To the north of Silver City is the Pinos Altos mountain, which consists, according to Mr. Gilbert, of granite, with porphyry overlapping on one side and the lavas of the Diablo range on the other. The veins are quartz veins, carrying both gold and silver, having a general north and south strike, and standing at a steep angle. According to the census specimens, they occur in both diabase and quartz-porphyry. At Lone mountain, to the south of Silver City, are ferruginous deposits, carrying chlorides and sulphides of silver, following the bedding of limestones, which dip to the northeast.

The Burro mountains to the west of Silver City consist, according to Howells, of two bodies of Archæan granite, the one covered by heavily-bedded trachytes, the other by Palæozoic beds dipping to the northeast. In the latter occur argentiferous lead ores, with chlorides and sulphurets of silver. Those in the Chloride Flat district occur between limestone beds, and those in the Silver Flat district between an overlying quartz-porphyry or diorite and an underlying limestone or dolomite. From the silver-bearing limestones Mr. Howells obtained characteristic fossils of the Cincinnati group.

In the Santa Rita mountains, according to Mr. Gilbert, argentiferous galena occurs in Carboniferous limestone, and veins carrying gold and copper in porphyry. The famous Santa Rita mines are near the crest of the range at the contact of the Carboniferous limestone and an overlying porphyry. The Shakspeare or Virginia district is about 25 miles southwest of the Burro mountains, in the Pyramid range, which is made up, according to Mr. Gilbert, of basalt and trachyte, overlying an older lava, in which occur the quartz veins. The most prominent of these stand up above the weathered surface of the rock, while others less prominent carry argentiferous galena ores with chloride and native silver. The country rock most probably belongs to the older or Secondary type of eruptives, although Mr. Gilbert describes it as resembling the propylite of v. Richthofen.

SANTA FÉ COUNTY.

Mine.	Country rock and vein.	Ore and gangue.
LOS CERRILLOS DISTRICT.		
Marshall Bonanza	Supposed to be rhyolite. Vein vertical; strike, N. 30° E.; 2 feet wide.	Argentiferous galena and cerussite, with black oxide of manganese and minute crystals of wulfenite (?).
SILVER BUTTE DISTRICT.		
San Pedro and Cañon del Agua.	Quartzite and porphyry on hanging wall; limestone on foot wall. No specimens. Deposit with the formation. Strike, N. and S.; dip, 15° E.; 80 feet thick.	Iron-stained quartz, with pyrite, carrying gold; 7 to 8 feet thick on hanging wall; underlaid by deposit of azurite, malachite, chrysocolla, cuprite, chalcopyrite, and bournonite. No specimens.

GRANT COUNTY.

CHLORIDE FLAT DISTRICT.		
Broken	Limestone; light-gray and crystalline on hanging wall, dark-blue and fine-grained on foot wall. Strike, N. 5° E.; dip, 15° E. Deposit in irregular bodies on foot wall.	Cerargyrite, argentite, and galena. Gangue: barite, fluorite, and argillaceous slate.
Providence	Dark-blue limestone or dolomite. Vein: strike, N. 40° W.; dip, 85° E.; average width, 2 feet.	Iron-stained quartz and limestone, carrying chlorides and sulphurets of silver.
LOKE MOUNTAIN DISTRICT.		
Cosette	Dolomitic limestone; light brown, crystalline, and called porphyry, on hanging wall; reddish with conchoidal fracture on foot wall. Deposits with the bedding. Strike, NW.; dip, 21° E., in irregular bodies.	Siliceous hematite, carrying chloride and sulphide of silver. Gangue: altered foot wall.
MIEMBRES DISTRICT.		
Commercial	Dark carbonaceous shale; foot wall, fossiliferous limestone. No specimens. Deposit in irregular pockets with the bedding; dip, SE.	Argentiferous. No specimens.
McGregor	Dark carbonaceous shale; foot wall, fossiliferous limestone. No specimens. Deposit in irregular pockets with the bedding; dip, SE.	Chlorides and sulphurets of silver, with cerussite and carbonate of iron in altered limestone.
Naiad Queen	Dark carbonaceous shale; foot wall, fossiliferous limestone. No specimens. Deposit in irregular pockets with the bedding; dip, SE.	Chlorides and sulphurets of silver and carbonates (?) of iron; free milling.

GRANT COUNTY—Continued.

Mine.	Country rock and vein.	Ore and gangue.
PINOS ALTOS DISTRICT.		
Langston	Much altered diabase, called limestone. Vein: strike, N. 15° E.; dip, 70° SE.	Gangue cerussite, chlorides, and sulphides of silver carrying gold.
Mina Grande	Called quartzless granite or trachyte. No specimens. Vein: strike, N. and S.; dip, 80° E.; 2 feet wide.	Auriferous quartz, with chlorides and sulphides of silver. No specimens.
Ohio	Decomposed quartz-porphyry. Vein: strike, N. and S.; dip, E.; 4 feet wide.	Galena, chalcopyrite, with barite in quartz, carrying gold and silver.
Pacific No. 2	Probably diabase. Vein: strike, N. and S.; dip, 75° E.; 2 feet wide.	Mixture of barite, quartz, pyrite, and galena, carrying gold and silver.
SILVER FLAT DISTRICT.		
Massachusetts and New Mexico.	Hanging wall light-colored quartz-porphyry; foot wall dark dolomite. Deposit with the bedding. Strike, N. 32° W.; dip, 85° E.; up to 15 feet thick.	Chlorides and sulphides of silver, with quartz and calcite.
Sherman	Hanging wall altered, eruptive rock, possibly diorite; foot wall dark-brown dolomite. Deposit with the bedding. Strike, N. and S.; dip, 15° E.	Galena, with chloride and sulphide of silver.

CHAPTER III.—DEEP MINES.

It is the purpose of this chapter to present a statement of the condition of the deep-mining industry in its various relations as far as it has proved practicable to obtain the information necessary for this object. An ideal canvass of the mines of the country would have led to absolute totals. It is conceivable, for example, that the actual sum-total of supplies consumed in all the mines should have been ascertained; but a moment's reflection will show that such a collection would be wholly impracticable, and, as has been explained in the preface, it was never contemplated. Mines containing less than 300 feet of shafts or galleries, or which had not produced 100 tons of ore, were not included in the examination. At many mines no separate account is kept of supplies consumed. Numerous mines, too, had changed hands during the census year, and the records of the earlier period were scattered or inaccessible, while others were abandoned or temporarily closed. No effort or expenditure would have sufficed to obtain substantially accurate totals on this and some other questions, and even a close approximation would have necessitated an outlay disproportionate to its importance. The tables of supplies are nevertheless both interesting and valuable, and show the total consumption, cost, and price of the principal articles purchased by nearly 600 of the most important mines of the country, the relative quantities of different supplies consumed, and the variations of this relation with the locality and with the kind of mining. The prices of an article of uniform quality, such as candles or quicksilver, in the different regions reported upon indicate the cost of transportation from the nearest large center, and inferences as to the natural resources of the region may be drawn from the prices of wood and salt. Though the table does not give even an approximation to the total cost of the supplies consumed in deep mining, it affords the means of reaching a rough, but for most purposes sufficiently close, estimate for considering the character of the mines from which reports have been received. It is probable that 50 per cent. of the supplies have been accounted for, and that the total expenditure in the deep precious-metal mines is not far from $10,000,000. It is somewhat important to know whether the supplies consumed by mines amounts to $10,000,000 or to $25,000,000 during the census year. Whether the exact sum was a few hundred thousand dollars more or less than ten millions is much less important, and for most purposes is of very little consequence. Similar remarks are applicable to other of the statistical tables presented for the deep mines.

The value of many of the tables is technical rather than economical, and these exhibit the mining practice of the country in a way which it is believed will be more welcome to mining men than any other, viz, as simple statements of facts, grouped according to locality. Technical mining is much the same the world over. Its principles and methods have long since been laid down in excellent treatises in many languages, and such novel features as have been developed in the mines of the far West have been described in Mr. J. D. Hague's admirable memoir, (*a*) in the reports of the mining commissioners, and in the proceedings of the American Institute of Mining Engineers. The details only of the applications of the recognized principles of mining differ with the character of the deposits and local conditions. The nature of the more important of these details will be clear to mining men of all countries from an inspection of the tables. In the chapters on milling and hydraulic mining, which are peculiar to the far West, and on furnace practice, which presents features unusual in other countries, technical discussions will accompany the statistical data, because their meaning would not otherwise be clear even to professional miners, whose experience has not been gathered west of the 100th meridian.

It cannot be too often insisted upon that this volume contains no estimates except where the fact is specifically noted. It would have been easy for those engaged in its preparation to have combined actual returns with special information, supplemented by hearsay, and to have evolved tables which would have presented an extremely satisfactory appearance; but there would have been no way of ascertaining the probable error of such tables, and the work would have lost all value except as an expression of personal opinion. Estimated tables, it is true, might have been published in addition to those founded on actual returns, but even now a great mass of valuable material derived from the schedules must be omitted for want of space, and had double the number of pages been at our disposal there would still have been no room for tables of opinions.

The number of reports upon which the figures are based is always given in the table, and varies with each, because answers to all the questions were obtained at extremely few mines, although each question was answered at a large number. There can be no doubt that some answers were incorrect, but an examination of the schedules, reprinted in the appendix, will show that several questions bear upon almost every point, and that a false or erroneous reply would nearly always lead to a contradiction, while a deliberate design to deceive, though none such

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a *Exploration of the Fortieth Parallel*, vol. III, Mining Industry.

may have existed, was guarded against by refusing to permit mine owners or superintendents to inspect the schedules. Wherever a contradiction was detected the conflicting data were rejected, and if any inconsistencies have escaped unnoticed the chances are that the errors involved, because of the large number of data from which they are derived, have produced no perceptible effect upon the tabulated results.

In preparing the tables the first step was to tabulate the data by mines. It would have been very desirable to publish such of these as involved no confidential information in full, but this would have increased the size of the work to an intolerable extent. They are therefore omitted, except in cases where the meaning of the facts would have been lost by aggregation.

The subjects illustrated by the tables of this chapter will be presented in the following order:

Position and altitude of the mining districts.
Ownership, organization, and value.
Development, its nature and extent.
Machinery and its manipulation.
Labor and wages.
Supplies, their consumption and cost.
Accidents, their causes and results.

POSITION AND ALTITUDE OF THE MINING DISTRICTS.

TABLE I.—DEEP MINES: MINING DISTRICTS, BY STATES OR TERRITORIES AND COUNTIES, WITH AVERAGE ALTITUDES.

State or territory and county.	District.	BY DISTRICTS.		BY COUNTIES.		BY STATES OR TERRITORIES.	
		Mines reported.	Average altitude.	Mines reported.	Average altitude.	Mines reported.	Average altitude.
		Number.	*Feet.*	*Number.*	*Feet.*	*Number.*	*Feet.*
The United States						939	7,089
ALABAMA.							
Cleburne		1	1,050	1	1,050		
Talladega	Township 18, range 6	1	760	1	760	2	905
ARIZONA.							
Maricopa	Globe	6	5,967				
Do		1	2,400	7	5,457		
Mohave	Hualapai	23	4,711				
Do	Maynard	1	6,800	23	4,802		
Pima	Arivaca	1	4,500				
Do	Dos Cabezas	3	5,950				
Do	Harshaw	8	6,133				
Do	Hartford	1	9,300				
Do	Ore Blanco	8	5,629				
Do	Pima	2	4,000				
Do	Swisshelm	2	5,000				
Do	Tombstone	19	5,042	35	5,229		
Pinal	Globe	4	4,700				
Do	Pioneer	2	3,325				
Do	Near Pioneer	1	4,200				
Do	Turquoise	1	5,600	8	4,408		
Yavapai	Big Bug	1	4,500				
Do	Cherry Creek	1	4,700				
Do	Humbug	1	3,000				
Do	Peck	2	5,650				
Do	Tiger	1	6,500	6	5,000		
Yuma	Castle Dome	1	2,500				
Do	Silver	1	3,000	2	2,750	81	4,988
CALIFORNIA.							
Amador	Amador City	2	1,325				
Do	Jackson	1	1,200				
Do	Plymouth	1	1,300				
Do	Sutter Creek	1	1,250	5	1,280		
Calaveras	Washington	1	2,800	1	2,800		
El Dorado	Springfield	1	1,900	1	1,900		
Fresno	Potter Ridge	1	3,200	1	3,500		
Inyo	Cerro Gordo	1	8,000				
Do	Lookout	1	3,300				
Do	Ruse	1	5,400	3	5,567		
Lassen	Hayden Hill	3	6,150	3	6,150		
Los Angeles	Silverado	1	2,500	1	2,500		
Mariposa	Coulterville	1	2,000				
Do	Mariposa Estate	1	1,200	3	1,650		
Mono	Blind Spring	1	6,200				
Do	Bodie	23	8,938				
Do	Indian	1	5,700	25	8,699		
Napa	Calistoga	1	800	1	800		
Nevada	Nevada City	2	2,715	2	2,715		
Placer	Colfax	1	2,400	1	2,400		
Plumas	Genesee Valley	1	3,700				
Do	Indian Valley	4	4,575				
Do	Quartz township	1	6,250				
Do	Seneca	1	3,500	7	4,838		
San Bernardino	Clark	2	5,475	2	5,475		

TABLE I.—DEEP MINES: MINING DISTRICTS, BY STATES OR TERRITORIES AND COUNTIES, ETC.—Continued.

State or territory and county.	District.	BY DISTRICTS.		BY COUNTIES.		BY STATES OR TERRITORIES.	
		Mines reported.	Average altitude.	Mines reported.	Average altitude.	Mines reported.	Average altitude.
CALIFORNIA—continued.		*Number.*	*Feet.*	*Number.*	*Feet.*	*Number.*	*Feet.*
San Diego	Banner	1	3,051				
Do	Cargo Muchacho	2	200	3	1,160		
Shasta	Pittsburg	1	1,300	1	1,300		
Siskiyou	Quartz Valley	1	3,500				
Do	Sawyer's Bar	1	4,400				
Do	South Fork Salmon	1	3,500	3	3,800		
Tuolumne	Soulsbyville	1	2,850	1	2,850	63	5,447
COLORADO.							
Boulder	Central	2	7,833				
Do	Gold Hill	10	7,447				
Do	Grand Island	7	8,528				
Do	Magnolia	2	6,940				
Do	Sugar Loaf	2	7,450				
Do	Ward	2	9,225	27	8,114		
Chaffee	Chalk Creek	2	11,933				
Do	Free Gold	1	7,000				
Do	Monarch	2	10,150	6	10,517		
Clear Creek	Argentine	1	12,400				
Do	Banner	2	9,275				
Do	Cascade	2	9,225				
Do	Chicago	1	8,500				
Do	Downieville	1	8,500				
Do	Geneva	1	11,000				
Do	Griffith	6	9,358				
Do	Griffith and Queens	1	8,500				
Do	Idaho	3	8,736				
Do	Iowa	1	8,000				
Do	Montana	2	8,250				
Do	Morris	3	8,067				
Do	Seaton	1	9,400				
Do	Spanish Bar	7	8,102				
Do	Trail Run	2	8,550				
Do	Upper Union	3	9,933				
Do	Virginia	3	8,853				
Do	York	1	8,900				
Custer	Hardscrabble	6	7,820	49	8,948		
Do	Verde	1	8,500				
Do		1	9,000	7	8,086		
Gilpin	Enterprise	2	8,500				
Do	Eureka	1	9,000				
Do	Gregory	10	8,230				
Do	Hawkeye	1	8,000				
Do	Mountain House	1	8,500				
Do	Nevada	12	8,985				
Do	Quartz Valley	1	8,650				
Do	Russell	7	8,733	36	8,704		
Gunnison	Ruby	1	10,000				
Do	Tin Cup	1	11,000	2	10,500		
Hinsdale	Galena	6	10,117				
Do	Lake	1	9,000				
Do	Park	1	12,000	8	10,212		
Huerfano	Third	1	10,000	1	10,000		
Lake	California	30	10,822				
Do	Homestake	1	12,500	31	10,876		
La Plata	California	1	8,300	1	8,800		
Ouray	Iron Springs	8	9,088				
Do	Pioneer	2	9,733				
Do	Sneffles	6	11,016				
Do	Uncompahgre	6	8,566				
Do	Upper San Miguel	8	11,137	31	10,184		
Park	Buckskin	1	12,000				
Do	Consolidated Montgomery	3	13,550				
Do	Horseshoe	1	13,150				
Do	Mosquito	4	12,044				
Do	Sacramento	1	11,400	9	12,425		
Rio Grande	Summit	1	12,000	1	12,000		
San Juan	Animas	15	10,680				
Do	Eureka	8	11,625				
Do	Uncompahgre	10	11,880	33	11,276		
Summit	Battle Mountain	3	10,000				
Do	Bevan	1	10,000				
Do	Consolidated Ten-mile	3	11,817				
Do	Horn Silver	1	9,000				
Do	McKay	1	10,000	8	10,656	250	8,784
DAKOTA.[a]							
Custer	Calo	2	7,000				
Do	Custer	6	6,253	8	6,440		
Lawrence	Bear Butte	15	6,131				
Do	Lost Placer	2	5,400				
Do	Whitewood	25	5,500	42	5,721		
Pennington	Cross	2	6,200				
Do	Newton Forks	3	5,833	5	6,020	55	5,953

TABLE I.—DEEP MINES: MINING DISTRICTS, BY STATES OR TERRITORIES AND COUNTIES, ETC.—Continued.

State or territory and county.	District.	BY DISTRICTS.		BY COUNTIES.		BY STATES OR TERRITORIES.	
		Mines reported.	Average altitude.	Mines reported.	Average altitude.	Mines reported.	Average altitude.
GEORGIA.		*Number.*	*Feet.*	*Number.*	*Feet.*	*Number.*	*Feet.*
Cherokee	New Hickory Flat	1	1,005				
Do	Third, section 2	1	1,290	2	1,148		
Forsyth	Third, section 1	1	1,290	1	1,290		
Hall	Ninth	2	1,345				
Do		1	740	3	1,143		
Lincoln		1	590	1	590		
McDuffie	Republican	1	580	1	580		
Meriwether	Lutherville 1281	1	950	1	950	9	1,013
IDAHO.							
Alturas	Bonaparte	1	6,350				
Do	Elk Creek		7,000				
Do	Hardscrabble		5,650				
Do	Middle Boisé	7	6,514				
Do	North Fork	1	8,000				
Do	Queen's River	2	5,825				
Do	Red Warrior	1	5,600				
Do	Rocky Bar, or Bear Creek	2	5,300				
Do	Sawtooth	3	9,200				
Do	Smiley's Basin		8,500				
Do	Wood River		6,500 to 10,000	17	6,788		
Boisé	Banner	2	7,650				
Do	Cañon Creek	2	5,905				
Do	Elkhorn		6,300				
Do	Gambrinus	1	6,500				
Do	Granite	1	7,000				
Do	Mammoth		7,900				
Do	Shaw's Mountain	3	4,733	9	6,000		
Lemhi	Bay Horse	1	9,500				
Do	Yankee Fork	3	8,467	4	8,725		
Owyhee	Carson	7	7,606				
Do	Wagontown	3	6,200	10	7,185	40	6,924
MAINE.							
Hancock	Gouldsboro'	2	42				
Do	Sullivan	4	25				
Do	West Sullivan	1	20	7	29		
Penobscot		1	200	1	200		
Washington	Fifth	1	125	1	125		
York	Acton	1	350	1	350	10	88
MONTANA.							
Beaver Head	Bald Mountain	1	8,000				
Do	Bannack	7	6,428				
Do	Trapper	2	9,650	10	7,230		
Deer Lodge	Flint Creek	5	6,220				
Do	Independence	2	5,800				
Do	McClellan's Gulch	1	7,000				
Do	Silver Creek	2	7,400				
Do	Summit Valley	24	5,906				
Do		1	6,500	35	6,121		
Jefferson	Cataract	3	6,600				
Do	Cedar Plains	1	5,000				
Do	Elkhorn	1	6,000				
Do	Mountain	1	6,000				
Do		3	5,250	7	5,814		
Lewis and Clarke	Ottawa	1	5,000				
Do	Owyhee	1	5,200				
Do	Silver Creek	1	6,500				
Do	Stemple	4	6,000	7	5,814		
Madison	Hot Springs	2	5,550				
Do	Lower Hot Springs	1	5,000				
Do	Mineral Hill	1	7,500				
Do	Red Bluff	1	5,000				
Do	Silver Shower	1	5,000				
Do	Silver Star	3	6,433	9	5,878	68	6,129
NEVADA.							
Elko	Columbia	1	7,000				
Do	Tuscarora	10	6,431	11	6,539		
Esmeralda	Columbus	5	6,415				
Do	Esmeralda	1	7,000				
Do	Oneota	1	8,000				
Do	Wilson	2	7,000	9	6,981		
Eureka	Cortez	1	7,400				
Do	Eureka	15	7,373				
Do	Secret Cañon	1	7,000	17	7,398		
Humboldt	Mount Rose	1	6,000				
Do	Sierra, or Dun Glen	1	6,000				
Do	Winnemucca	1	5,800	3	5,933		
Lander	Battle Mountain	1	6,500				
Do	Lewis	1	7,500				
Do	Reese River	1	7,300	3	7,100		

TABLE I.—DEEP MINES: MINING DISTRICTS, BY STATES OR TERRITORIES AND COUNTIES, ETC.—Continued.

State or territory and county.	District.	BY DISTRICTS.		BY COUNTIES.		BY STATES OR TERRITORIES.	
		Mines reported.	Average altitude.	Mines reported.	Average altitude.	Mines reported.	Average altitude.
NEVADA—continued.		*Number.*	*Feet.*	*Number.*	*Feet.*	*Number.*	*Feet.*
Lincoln	Bristol	2	6,300				
Do	Eldorado	1	1,700				
Do	Ely	2	6,200				
Do	Jack Rabbit	1	7,500	6	6,387		
Nye	Morey	1	6,200				
Do	Tybo						
Do	Union	1	6,500				
Storey	American Flat	2	7,550	4	7,450		
Do	Gold Hill	1	5,729				
Do	Virginia	13	5,803				
		20	6,105	33	5,984		
Storey and Lyon	(Sutro tunnel)						
White Pine	Cherry Creek	1	4,483	1	4,483		
Do	Ward	3	7,233				
Do	White Pine	1	8,000				
		3	9,500	6	8,117	93	6,633
NEW HAMPSHIRE.							
Coos	Shelburne	1	1,000	1	1,000		
Grafton	Ammonoosuc	1	700	1	700	2	850
NEW MEXICO.							
Grant	Chloride Flat	2	6,300				
Do	Lone Mountain	1	6,300				
Do	Miembres	3	7,000				
Do	Pinos Altos	6	6,850				
Do	Silver Flat	1	6,300	12	6,700		
Santa Fé	Los Cerrillos	1	6,800	1	6,800	13	6,715
NORTH CAROLINA.							
Davidson	Emmons township	1	745				
Do	Thomasville township	1	660				
Do		2	750	4	711		
Guilford	Capp's Hill	1	900	1	900		
Mecklenburg		1	930				
Do	Sixth						
Moore		1	785	2	858		
Nash	Griffith township	1	460	1	460		
Rowan		1	390	1	390		
Stanley		1	1,050	1	1,050		
Tuston		1	1,200	1	1,200		
		1	1,075	1	1,075	12	803
OREGON.							
Baker	Burnt River	1	4,425				
Do	Conner Creek	1	3,300				
Do	Rye Valley	1	5,000				
Do	Silver Creek	1	7,500				
		1	3,000	5	4,645		
Grant	Granite						
Josephine	Yank	2	6,950	2	6,950		
		1	2,000	1	2,000	8	4,801
UTAH.							
Beaver	Bradshaw						
Do	San Francisco	1	6,600				
Do	Star	4	6,675				
Juab	Tintic	2	5,625	7	6,364		
Piute	Mount Baldy	9	6,222	9	6,222		
		1	7,500				
Do	Ohio						
Salt Lake	Big Cottonwood	1	8,500	2	8,000		
Do	Little Cottonwood	8	9,944				
Do	West Mountain	9	9,511				
Summit	Uintah	12	6,647	29	8,480		
		5	8,400	5	8,460		
Tooele	Camp Floyd						
Do	Ophir	1	7,000				
Do	Ruah Valley	7	8,100				
Utah	American Fork	2	6,400	10	7,650		
Do	Silver Lake	4	9,725				
		2	8,500	6	9,317		
Wasatch	Blue Ledge						
Do	Snake Creek	1	8,000				
Washington	Harrisburg, or Silver Reef	3	9,633	4	9,225		
		8	3,923	8	3,922	80	7,555
VIRGINIA.							
Culpeper		1	400	1	400		
Fauquier		1	250	1	250		
Louisa	Cochoo township	1	320	1	320		
Stafford	Hartford township	1	225	1	225	4	299
WASHINGTON.							
Yakima	Peshaston	1	2,000	1	2,000	1	2,000
WYOMING.							
Sweetwater	California						
Do	Miner's Delight	6	7,500				
Do	Sheahone	3	7,933				
		3	7,500	12	7,688	12	7,688

This table shows the distribution of mining districts by states or territories and counties, with their average altitudes, and thus contains both geographical and topographical information. The slightest knowledge of the general altitudes of the different parts of the country in connection with this table shows that in the United States, as throughout the world, the mines are in the mountains. The degree of accuracy of the several altitudes given varies greatly, for while many of them have been determined by actual leveling, others have been ascertained by barometrical observations, while in some remote districts the elevation is merely estimated by comparison with the nearest known points. The various government and railroad surveys, however, have established the altitude of so great a number of points throughout the West that few mines are at great distances from localities of known elevation. Where definite information is lacking, the tendency is to overestimate the altitude.

TABLE II.—DEEP MINES: NUMBER OF MINES, BY ALTITUDES, AND BY STATES AND TERRITORIES.

State or territory.	Total number of mines reported.	Under 1,000 feet.	Over 1,000 and under 2,000.	Over 2,000 and under 3,000.	Over 3,000 and under 4,000.	Over 4,000 and under 5,000.	Over 5,000 and under 6,000.	Over 6,000 and under 7,000.	Over 7,000 and under 8,000.	Over 8,000 and under 9,000.	Over 9,000 and under 10,000.	Over 10,000 and under 11,000.	Over 11,000 and under 12,000.	Over 12,000 and under 13,000.	Over 13,000 and under 14,000.
The United States	803	33	19	10	18	44	122	153	88	105	87	61	33	28	4
Alabama	2	1	1												
Arizona	81			2	5	29	33	11			1				
California	63	3	8	6	3	5	4	5		18	6				
Colorado	250							3	21	56	56	53	29	28	4
Dakota	55						28	26	3						
Georgia	9	4	5												
Idaho	40					2	9	12	9	4	4				
Maine	10	10													
Montana	68					1	27	29	6	3	3				
Nevada	93		1			1	15	46	19	8	3				
New Hampshire	2	1	1												
New Mexico	13							6	7						
North Carolina	12	9	3												
Oregon	8			1	3	1	1	1	3						
Utah	80				3	5	7	14	11	15	14	8	3		
Virginia	4	4													
Washington	1			1											
Wyoming	12								10	2					

A part of the results of Table I are here presented in a more condensed form, in order that they may be more readily appreciated, and it appears that about one-third of the mines of the country lie between 5,000 and 7,000 feet above sea-level. The distribution by level in the different states is characteristic. In California, owing to the considerable number of useful minerals extracted and to the occurrence of deposits in the Coast ranges as well as in the Sierra, mines are pretty evenly distributed from the sea-level to 10,000 feet above it, while in Colorado there are more mines above 12,000 feet than below 8,000 feet, and in Dakota all mines reported lie between 5,000 and 7,000 feet.

TABLE III.—DEEP MINES: HIGHEST, LOWEST, AND MEAN ALTITUDE OF THE MINES, BY STATES AND TERRITORIES.

State or territory.	ALTITUDE OF THE MINES.		
	Highest.	Lowest.	Mean.
The United States	*Feet.* 13,800	*Feet.* Tide-water.	*Feet.* 7,069
Alabama	1,650	700	905
Arizona	9,300	2,400	4,968
California	9,194	200	5,447
Colorado	13,800	6,500	9,784
Dakota	7,000	5,000	5,853
Georgia	1,250	580	1,015
Idaho	10,000	4,500	6,934
Maine	350	Tide-water.	88
Montana	9,800	5,000	6,189
Nevada	9,700	1,700	6,632
New Hampshire	1,900	700	850
New Mexico	7,000	6,300	6,715
North Carolina	1,200	300	863
Oregon	7,500	2,000	4,801
Utah	11,900	3,450	7,535
Virginia	400	225	290
Washington	2,000	2,000	2,000
Wyoming	8,000	7,500	7,808

TABLE IV.—ALTITUDES OF SHAFTS OF THE COMSTOCK MINES IN REFERENCE TO THE SUTRO TUNNEL.

Name.	Altitude above sea-level.	Altitude above mouth of Sutro tunnel.	Altitude above point nearest to the shaft in Sutro tunnel.
	Feet.	*Feet.*	*Feet.*
Bullion	6,207	1,824	1,778.3
Cholar-Potosi	6,226	1,743	1,695.2
Donner	6,194	1,711	1,663.8
Savage	6,181	1,698	1,663.8
Consolidated Imperial	6,169	1,677	1,626.3
Hale & Norcross	6,157	1,674	1,627.8
Consolidated Virginia	6,156	1,673	1,623.6
Combination	6,133	1,650	1,618.8
Ophir	6,131	1,648	1,597.1
Ward	6,118	1,635	1,584.9
Julia	6,116	1,633	1,585.2
Union	6,088	1,595	1,531.7
Yellow Jacket (new)	6,051	1,568	1,514.1
C. & C	6,038	1,555	1,505.6
Forman	6,038	1,555	1,495.4
Sierra Nevada	6,031	1,548	1,492.6
Utah	5,996	1,513	1,453.4
Belcher	5,981	1,498	1,444.1
Belcher (old)	5,981	1,498	1,444.1
Gabiston	5,969	1,583	1,430.1
Yellow Jacket (old)	5,961	1,478	1,434.1
Crown Point	5,925	1,442	1,388.1
Mint	5,892	1,409	1,363.1
Overman (old)	5,731	1,248	1,192.5

In this table the altitudes refer to the tops of the shafts. In one sense the data are of merely local importance, but the Comstock lode represents so large a portion of the mining interests of the far West that facts concerning it are welcome to a very large number of persons.

TABLE V.—DEEP MINES: AMERICAN OWNERSHIP.

State or territory in which mines are located.	Total number of mines of American ownership reported.	Owned in state or territory where located.	OWNED IN OTHER STATES OR TERRITORIES THAN THOSE IN WHICH THE MINES ARE LOCATED.																						
			Total owned in other states or territories.	New York.	California.	Pennsylvania.	Massachusetts.	Illinois.	Missouri.	Ohio.	Michigan.	Utah.	Maryland.	Indiana.	Iowa.	Colorado.	Kansas.	Minnesota.	Nebraska.	Wisconsin.	Connecticut.	District of Columbia.	Maine.	Tennessee.	Virginia.	Wyoming.
The United States	1,155	789	366	148	105	20	16	15	12	12	5	7	4	3	3	2	2	2	2	2	1	1	1	1	1
Alabama	2	2																							
Arizona	71	16	55	23	16	6	1	1	4	1				1				1							
California	101	94	7	5			2																1		
Colorado	248	146	102	68		3	5	9	5	2	3		2				2		1	1				1	
Dakota	56	34	22	5	9			2	1						2			1		1					1
Georgia	10	7	3				2																		
Idaho	254	224	30	11	8		1			3		6		1							1				
Maine	11	11																							
Montana	70	59	11	5		3			1			1		1											
Nevada	97	16	81	9	66	2	1				1														
New Hampshire	3	2	1																						
New Mexico	14	10	4	2			2															1			
North Carolina	12	3	9	6		1							2												
Oregon	9	8	1		1																				
Utah	179	143	36	11	3	5	2	3	1	6	1				1	2			1						
Virginia	5	1	4	3																	1				
Washington	1	1																							
Wyoming	12	12																							

Of mines owned in the United States:	Per cent.
Owned in the state or territory where located	68.31
Owned in other states or territories than those in which mines are located	31.69

Table V includes only the more important mines; that is, those considered worth reporting upon for other purposes than that of ascertaining the ownership merely. It therefore omits a very large number of mines which have been incorporated in San Francisco, New York, etc., as well as the many prospects owned in the district where

located. For example, of several hundred mines of Nevada owned by corporations, and at one time or another listed on the San Francisco stock exchanges, only 68 appear in the table. It nevertheless embraces a sufficient portion of the mines which have been profitable, or which have held forth sufficient promise to authorize active operations, to fairly represent the distribution of ownership in the several states. It will be observed that New York and California own about 70 per cent. of the mines in other states which are included in the table.

TABLE VI.—DEEP MINES: NATIONALITY OF OWNERSHIP.

State or territory.	Number of mines reported.	OWNERSHIP.					
		American.	Foreign.				
			Total foreign.	English.	Anglo-American.	French.	Dutch.
The United States...	1,172	1,155	17	14	1	1	1
Alabama	2	2					
Arizona	71	71					
California	105	101	4	4			
Colorado	251	248	3	3			
Dakota	56	56					
Georgia	10	10					
Idaho	254	254					
Maine	11	11					
Montana	70	70					
Nevada	100	97	3	3			
New Hampshire	3	3					
New Mexico	14	14					
North Carolina	12	12					
Oregon	9	9					
Utah	186	179	7	4	1	1	1
Virginia	5	5					
Washington	1	1					
Wyoming	12	12					

	Per cent.
American ownership	98.55
Foreign ownership	1.45

The amount of American mining property owned outside of the United States is extremely small, and of the foreign owners, as might have been supposed, nearly all are English.

TABLE VII.—DEEP MINES: OWNERSHIP (PERCENTAGES).

State or territory.	AMERICAN OWNERSHIP.			Foreign ownership.
	Total.	Owned in state or territory where located.	Owned in other states or territories than those in which the mines are located.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
The United States	98.55	67.32	31.23	1.45
Alabama	100.00	100.00		
Arizona	100.00	22.54	77.46	
California	96.19	89.52	6.67	3.81
Colorado	98.80	58.17	40.63	1.20
Dakota	100.00	60.71	39.29	
Georgia	100.00	70.00	30.00	
Idaho	100.00	88.19	11.81	
Maine	100.00	100.00		
Montana	100.00	84.29	15.71	
Nevada	97.00	18.00	81.00	3.00
New Hampshire	100.00	66.67	33.33	
New Mexico	100.00	71.43	28.57	
North Carolina	100.00	25.00	75.00	
Oregon	100.00	88.89	11.11	
Utah	96.24	76.88	19.36	3.76
Virginia	100.00	20.00	80.00	
Washington	100.00	100.00		
Wyoming	100.00	100.00		

As a rule, the greater number of mines of each state and territory are owned within its limits, Nevada and Arizona furnishing the only exceptions west of the 100th meridian. A smaller portion of California mining property is owned elsewhere than is the case with any other important mining state or territory of the far West, as appears from Table VII. Nevada mines are chiefly owned in California, while those of Arizona and Colorado are largely in the hands of New York capitalists. The proportion of mining property owned in foreign countries is very small in all the states and territories.

DEEP MINES: NATURE OF TITLE.

Fully patented	269
Other titles	451
	720
Partially patented (including patent and purchase, part patent and part discovery, part patented and part patent applied for)	31
Other titles	689
	720
Patented, part patented, or patent applied for	388
Other titles	332
	720
Location (or discovery) and possessory	221
Other titles	499
	720
Fee-simple, warrantee deed, quit-claim deed, or "mineral deed"	27
Other titles	693
	720

TABLE VIII.—DEEP MINES: NATURE OF TITLE, BY STATES AND TERRITORIES.

State or territory.	Number of mines reported.	United States patent.	Part patented.	Patent and purchase.	Part patent and part discovery.	Part patented and part patent applied for.	Patent applied for.	Location (or discovery).	Discovery and purchase.	Purchase.	Purchase and lease.	Fee-simple.	Warrantee deed.	Quit-claim deed.	"Mineral deed."	Lease.	Segregation.	Consolidation.	Surface title by purchase.	Tunnel right under United States mining laws.	Possessory.
The United States	720	269	7	4	11	9	88	209	7	60	3	20	3	2	2	7	3	1	2	1	12
Arizona	60	5	.....	.....	.....	.....	2	49	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
California	76	37	.....	.....	.....	.....	18	12	1	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
Colorado	208	106	4	.....	9	6	38	36	.....	1	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	7
Dakota	11	3	.....	.....	.....	2	4	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Georgia	9	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	6	.....	.....	.....	1	.....	.....	.....	.....	.....
Idaho	36	.....	.....	.....	.....	.....	.....	12	1	23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Maine	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	1	1	.....	.....	4	.....	.....	.....	.....	.....
Montana	60	32	.....	.....	.....	1	8	15	1	1	.....	.....	.....	1	.....	1	.....	.....	.....	.....	.....
Nevada	88	37	2	4	2	.....	.....	17	.....	19	.....	.....	.....	.....	.....	.....	3	1	2	.....	1
New Hampshire	3	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....
New Mexico	13	3	.....	.....	.....	.....	3	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
North Carolina	11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	1	.....	.....	1	.....	.....	.....	.....	.....
Oregon	8	1	.....	.....	.....	.....	1	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Utah	110	45	1	.....	.....	.....	14	43	4	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Virginia	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	1	.....	.....	.....	.....	.....	.....	.....	.....
Washington	1	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wyoming	12	.....	.....	.....	.....	.....	.....	8	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

The nature of titles in these tables is given as reported to the special experts by the superintendents of the mines, but they are no doubt in some cases inaccurate, many superintendents being either imperfectly acquainted with the histories of the properties which they have in charge, or having a very imperfect knowledge of mining law. The table nevertheless represents pretty closely the character of the tenure of the mines reported on. Had the standard of mines reported upon been lower, a much larger proportion of the titles would have appeared as by right of location, the smaller mines being nearly always held in this way. The preceding analysis exhibits a comparison of titles.

The subject of mining titles is one of great complexity and delicacy, and much too large a share of the profits of the industry in the United States has been expended in litigation over the right to mining property. Such brief remarks as might be in place here, however, are omitted, because the subject will be amply discussed in the volume on mining law.

TABLE IX.—DEEP MINES: CAPITAL STOCK.

RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	Number of corporations making returns.	Capital stock (nominal).
The United States	422	$2,030,702,550
Arizona	38	190,490,000
California	66	376,901,250
Colorado	126	325,902,300
Dakota	21	118,800,000
Georgia	3	1,510,000
Idaho	13	54,145,000
Maine	11	6,400,000
Montana	9	19,950,000
Nevada	78	759,645,000
New Hampshire	1	500,000
New Mexico	2	2,600,000
North Carolina	6	5,500,000
Oregon	2	5,000,000
Utah	42	156,200,000
Virginia	3	750,000
Washington	1	400,000

This table includes the foreign corporations, the pound sterling being taken at $5 and the franc at 20 cents. The list covers only such mines as came within the standard fixed for this investigation. The total is therefore far smaller than one which would include all the claims which have been placed upon the market by incorporated companies, the practice in the Pacific states being to capitalize almost invariably at $10,000,000, in 100,000 shares of $100 each, without regard to the value or prospective value of the property. Thousands of such companies have been floated in San Francisco. As an interesting comparison, the list of stocks dealt in at the San Francisco exchanges June 1, 1880, is also given, with the amount of nominal capital represented. The difference between the number of actively working Comstock mines and the host of wildcat, idle, and abandoned claims of that district is very marked.

TABLE X.—DEEP MINES: LIST OF MINING STOCKS DEALT IN AT THE SAN FRANCISCO BOARDS AT CLOSE OF CENSUS YEAR.

WASHOE MINES. (a)

Company.	Capital stock.	Company.	Capital stock.	Company.	Capital stock.
Alpha Consolidated	$3,000,000	Georgia	$10,000,000	Orleans	$4,800,000
Alta	10,800,000	Golden Gate	10,000,000	Overman	11,520,000
Amazon Consolidated	6,000,000	Gould & Curry	10,800,000	Patten	5,000,000
American Flat	3,000,000	Green	2,000,000	Peytona	10,000,000
Andes	10,000,000	Hale & Norcross	11,200,000	Phil. Sheridan	10,000,000
Atlantic Consolidated	10,000,000	Hartford	10,500,000	Pioneer	10,000,000
Baltic Consolidated	3,700,000	Insurance	3,000,000	Plutus	12,000,000
Baltimore Consolidated	8,400,000	Joe Seates	10,000,000	Potosi	11,200,000
Belcher	10,400,000	Julia Consolidated	11,000,000	Prospect	10,000,000
Benton Consolidated	10,800,000	Justice	10,500,000	Sabine	10,000,000
Best & Belcher	10,080,000	Keating	10,000,000	Savage	11,200,000
Brilliant	10,000,000	Kentuck	3,000,000	Scorpion	10,000,000
Buckeye	4,800,000	Kossuth	10,800,000	Segregated Belcher	640,000
Bullion	10,000,000	Lady Bryan	10,000,000	Segregated Gold Hill	6,000,000
Caledonia	10,000,000	Lady Washington	10,800,000	Senator	10,800,000
California	54,000,000	Lee	10,000,000	Sierra Nevada	10,000,000
Challenge Consolidated	5,000,000	Leviathan	10,000,000	Silver City	6,310,000
Cherokee	6,000,000	Mackey	10,000,000	Silver Hill	10,800,000
Chollar	11,200,000	Margarita	15,000,000	Solid Silver	10,000,000
Concordia	15,000,000	Mary Ann	10,500,000	South Comstock	10,000,000
Confidence	2,496,000	Maryland	5,400,000	South Justice	10,000,000
Consolidated Imperial	50,000,000	Mexican	10,800,000	South Lady Bryan	10,000,000
Consolidated Dorado	10,000,000	Mides	3,000,000	South Potosi	10,000,000
Consolidated Virginia	54,000,000	Mint	5,000,000	South Utah	10,000,000
Consolidated Washoe	4,000,000	Morisco	10,000,000	Saint Louis	10,800,000
Cosmopolitan	10,000,000	Morning Star	8,000,000	Succor	6,840,000
Crown Point	10,000,000	Mount Hood	10,000,000	Sutro	2,400,000
Crown Point Extension	4,000,000	Mountain View	10,000,000	Thornton	10,000,000
Crown Point Ravine	3,000,000	Nevada	4,000,000	Tolo	10,000,000
Daney	10,800,000	New York	10,000,000	Trojan	10,000,000
Dardanelles	6,000,000	Niagara	6,000,000	Union Consolidated	10,000,000
Dayton	10,000,000	North Bonanza	10,000,000	Utah	2,000,000
De Haro	10,000,000	North Carson	10,000,000	Vancouver	10,000,000
Erie Consolidated	10,000,000	North Consolidated Virginia	10,000,000	Vermont Consolidated	11,000,000
Europa	10,000,000	North Ophir	10,000,000	Virian	5,000,000
Exchequer	10,000,000	North Sierra Nevada	10,000,000	Ward	11,000,000
Fairfax	10,000,000	North Utah	6,000,000	Warsaw	10,000,000
Flowery	10,000,000	Occidental	4,000,000	Wells Fargo	10,800,000
Franklin	3,000,000	Ophir	10,080,000	Woodville Consolidated	12,000,000
Garber	12,000,000	Original Gold Hill	3,000,000	Yellow Jacket	12,000,000
George Douglass	10,000,000	Original Keystone	10,000,000		

a Capital stock of Bonanza, Chonta, Capital, Little York, Lower Comstock, and Santiago not ascertained.

TABLE X.—DEEP MINES: LIST OF MINING STOCKS, ETC.—Continued.

BODIE MINES. (a)

Company.	Capital stock.	Company.	Capital stock.	Company.	Capital stock.
Addenda	$10,000,000	Double Standard	$5,000,000	Riqueza	$10,000,000
Aurora Tunnel	6,000,000	Dudley	6,400,000	Rough and Ready Consolidated	10,000,000
Bechtel Consolidated	10,000,000	Glyndale Consolidated	10,000,000	Rustler	6,000,000
Belvidere	10,000,000	Goodshaw	10,000,000	Santa Mina	5,000,000
Black Hawk	5,000,000	Ida	6,000,000	South Bodie	10,000,000
Bodie Chief	10,000,000	Jupiter	6,400,000	South Bulwer	10,000,000
Bodie Consolidated	10,000,000	Maybell Consolidated	6,000,000	South Standard	10,000,000
Booker Consolidated	10,000,000	McClinton	6,000,000	Standard Consolidated	10,000,000
Boston Consolidated	10,000,000	Mono	5,000,000	Summit	5,000,000
Bulwer Consolidated	10,000,000	Noonday	6,000,000	Syndicate	10,000,000
Champion	10,000,000	North Noonday	6,000,000	Tioga Consolidated	10,000,000
Chieftain	10,000,000	Orient	10,000,000	University	10,000,000
Concordia	6,000,000	Oro	10,000,000	Vortex	6,000,000
Consolidated Pacific	6,000,000	Queen Bee	10,000,000	West Pacific	10,000,000
Croesus	5,000,000	Red Cloud Consolidated	5,000,000	White Cloud	6,000,000
Defiance	5,000,000	Richter	5,000,000		

a Capital stock of Klamath company not ascertained.

NEVADA (EXCEPTING WASHOE).

Adams Hill Consolidated	$5,000,000	General Thomas	$5,000,000	Mount Potosi Consolidated	$10,000,000
Albion Consolidated	15,000,000	Gila	10,000,000	Navajo	9,000,000
American Flag	4,000,000	Grand Prize	10,000,000	North Belle Isle	10,000,000
Argenta	10,000,000	Hamburgh	10,000,000	Northern Belle	5,000,000
Atlas	10,000,000	Highbridge	10,000,000	Original Hidden Treasure	2,133,000
Belle Isle	10,000,000	Hillside	10,000,000	Panther	5,000,000
Belmont	5,000,000	Hussey Consolidated	10,000,000	Paradise Valley	10,000,000
Big Prize	10,000,000	Independence	10,000,000	Phœnix	5,000,000
Blue Jacket	10,000,000	Indian Queen	250,000	Pleiades	10,000,000
Columbia Consolidated	5,000,000	Jackson	5,000,000	Raymond & Ely	10,000,000
Consolidated Esmeralda	10,000,000	K. K. Consolidated	5,000,000	Real del Monte	5,000,000
Day	10,000,000	Leopard	5,000,000	Rye Patch Consolidated	3,000,000
DeFrece	10,000,000	Manhattan	5,000,000	Silver Prize	10,000,000
Eagle	6,000,000	Martin White	10,000,000	Star	10,000,000
East Mount Diablo	10,000,000	Meadow Valley	6,000,000	Tuscarora	10,000,000
El Dorado South Consolidated	4,000,000	Metallic	5,000,000	Tybo Consolidated	15,000,000
Endowment	10,000,000	Monitor-Belmont	5,000,000	Wales Consolidated	10,000,000
Eureka Consolidated	5,000,000	Mount Diablo	5,000,000	Young America	6,000,000
Fourth of July	20,000,000				

CALIFORNIA (EXCEPTING BODIE).

Comanche	$5,000,000	Modoc Consolidated	$10,000,000	Oriental Consolidated	$5,000,000
Consolidated Amador	3,000,000	New Coso	10,000,000	South Modoc	10,000,000
Mammoth	10,000,000				

DAKOTA.

Caledonia	$10,000,000	Golden Terra	$10,000,000	Homestake	$10,000,000
Giant and Old Abe	10,000,000				

ARIZONA.

San Xavier	$10,000,000	Silver King	$10,000,000	Tip-Top	$10,000,000

IDAHO.

Florida Hill	$10,000,000	Golden Chariot	$2,000,000		

UTAH.

Leeds	$6,000,000				

SCATTERED.

Consolidated Arizona	$10,000,000	Revenue	$10,000,000	Silver West Consolidated	$5,000,000
Price & Davies	10,000,000				

RECAPITULATION.

Location of mine.	Number of corporations making returns.	Capital stock.
Total	245	$2, 175, 140, 000
Washoe	122	1, 187, 966, 000
Nevada (excepting Washoe)	55	430, 383, 000
Bodie	47	373, 800, 000
California (excepting Bodie)	7	53, 000, 000
Dakota	4	40, 000, 000
Arizona	3	30, 000, 000
Idaho	2	19, 000, 000
Utah	1	6, 000, 000
Scattered	4	35, 000, 000

TABLE XI.—DEEP MINES: MARKET VALUATION OF STOCK OF MINING COMPANIES JUNE 1, 1880, IN COMPARISON WITH NOMINAL CAPITAL STOCK.

RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	Number of corporations making returns.	Capital stock.	Market valuation.
Total	140	$1, 019, 111, 250	$85. 641, 222
Arizona	11	52. 000, 000	9, 790, 000
California	25	195, 806, 250	8, 750, 312
Colorado	30	142, 100, 000	23, 925, 000
Dakota	13	81, 550, 000	9, 975, 000
Georgia	1	10, 000	10, 000
Idaho	1	10, 000, 000	550, 000
Maine	4	2, 300, 000	425, 000
Montana	2	5, 100, 000	2, 700, 000
Nevada	43	509, 045, 000	20, 170, 910
New Mexico	1	100, 000	125, 000
North Carolina	3	2, 200, 000	320, 000
Oregon	2	5, 000, 000	875, 000
Utah	3	13, 500, 000	7, 825, 000
Washington	1	400, 000	200, 000

The data obtained for this table are so scanty that it is valuable merely as a representative example of the differences between nominal capital and market value. So far as the comparison is concerned, an absolutely complete table would scarcely serve any further purpose, the practice as to capitalization varying with the locality of the market rather than with the value of the property. A complete table of the market value, on the other hand, would have possessed considerable interest had it been attainable, but definite conclusions as to the real value of the mines could scarcely have been drawn from it, inasmuch as the quoted market value of stocks is greatly affected by speculation, and is in a measure fictitious, sales of a few shares often being made at prices far exceeding those which could be obtained on any considerable proportion of the entire property. A very large part of the best mines, too, are not upon the market at all, and their owners, even if they desired to sell, could only tell the asking price, not that which could be realized.

Several mines, though quoted in the stock markets during the census year, are not reported in the schedules because they did not come within the prescribed limits or were not actively worked during the year, while many of the mines included in the schedules and belonging to stock companies were not quoted on the stock boards, and consequently do not appear in the table.

TABLE XII.—DEEP MINES: FINANCIAL SHOWING OF MINING COMPANIES WHOSE STOCKS WERE DEALT IN AT THE SAN FRANCISCO BOARDS AT CLOSE OF CENSUS YEAR, FOR THAT AND PREVIOUS YEARS.

Company.	Dividends.		Assessments.		Profit.	Loss.
	No.	Amount.	No.	Amount.		
WASHOE MINES	209	$115,871,100	1,000	$61,715,535	$97,547,430	$43,891,865
Alpha Consolidated			12	330,000		330,000
Alta			17	1,317,000		1,317,000
Amazon Consolidated			6	54,000		54,000
American Flat			7	172,500		172,500
Andes			14	425,000		425,000
Atlantic Consolidated			3	45,000		45,000
Baltimore Consolidated			19	1,015,000		1,015,000
Belcher	38	15,897,200	23	1,900,000	13,497,200	
Benton Consolidated			3	162,000		162,000
Best & Belcher			17	942,590		942,590
Brilliant			4	25,000		25,000
Buckeye			19	332,000		332,000
Bullion			14	3,352,000		3,352,000
Caledonia			31	1,995,000		1,995,000
California	34	31,320,000			31,320,000	
Challenge Consolidated			1	10,000		10,000
Chollar			3	168,000		168,000
Confidence	6	78,000	11	256,320		178,320
Consolidated Imperial			11	1,125,000		1,125,000
Consolidated Dorado			1	50,000		50,000
Consolidated Virginia	51	42,990,000	15	411,200	41,978,800	
Consolidated Washoe			1	8,000		8,000
Cosmopolitan			5	125,000		125,000
Crown Point	50	11,588,000	41	2,373,370	9,214,630	
Crown Point Ravine			6	49,500		49,500
Daney	2	56,000	5	91,800		35,800
Dardanelles			7	390,000		390,000
Dayton			10	750,000		750,000
De Haro			2	25,000		25,000
Erie Consolidated			1	10,000		10,000
Europa			8	126,000		126,000
Exchequer			15	530,000		530,000
Fairfax			2	35,000		35,000
Flowery			3	100,000		100,000
Franklin			4			
George Douglass			3	45,000		45,000
Georgia			1	10,000		10,000
Golden Gate			1	100,000		100,000
Gould & Curry	38	3,826,800	37	3,152,000	674,800	
Green			14			
Hale & Norcross	36	1,506,000	54	3,306,000		1,706,000
Hartford			5	14,700		14,700
Insurance			3	18,000		18,000
Joe Scates			4	95,000		95,000
Julia Consolidated			12	1,229,000		1,229,000
Justice	5					
Kentuck	32	1,252,000	33	3,230,000		3,230,000
Kossuth			13	300,000	952,000	
Lady Bryan			8	421,200		421,200
Lady Washington			4	200,000		200,000
Lee			1	21,600		21,600
Leviathan			1	5,000		5,000
Mackey			10	315,000		315,000
Mary Ann			3	35,000		35,000
Maryland			1	10,500		10,500
Mexican			1	5,400		5,400
Midas			11	1,243,000		1,243,000
Mint			2	21,000		21,000
Mount Hood			22	142,500		142,500
Mountain View			3	35,000		35,000
Nevada			1	25,000		25,000
New York			3	18,000		18,000
Niagara			22	900,000		900,000
North Bonanza			5	99,000		99,000
North Carson			5	175,000		175,000
North Consolidated Virginia			9	160,000		160,000
North Sierra Nevada			16	830,000		830,000
Occidental			2	10,000		10,000
Ophir			6	112,500		112,500
Original Gold Hill	24	1,596,800	25	2,689,400		1,093,600
Original Keystone			3	102,000		102,000
Overman			3	125,000		125,000
Patten			45	3,162,800		3,162,800
Peytona			2	20,000		20,000
Phil. Sheridan			2	70,000		70,000
Pioneer			9	145,000		145,000
Potosi			2	15,000		15,000
Prospect			3	168,000		168,000
Sabine			6	260,000		260,000
Savage	52	4,460,000	2	25,000		25,000
			42	4,964,000		504,000
Scorpion			7	122,000		122,000
Segregated Belcher			16	264,000		264,000
Segregated Gold Hill			1	12,000		12,000
Senator			1	10,800		10,800
Sierra Nevada	11	102,500	63	3,856,000		3,747,500

TABLE XII.—DEEP MINES: FINANCIAL SHOWING OF MINING COMPANIES, ETC.—Continued.

Company.	Dividends.		Assessments.		Profit.	Loss.
	No.	Amount.	No.	Amount.		
Silver City			1	$15,775		$15,775
Silver Hill			10	1,620,000		1,620,000
Solid Silver			3	75,000		75,000
South Comstock			6	79,000		79,000
South Utah			4	35,000		35,000
Saint Louis			1	16,200		16,200
Succor	2	$22,800	24	798,000		775,200
Sutro			4	25,680		25,680
Tolo			2	23,000		23,000
Trojan			12	315,000		315,000
Union Consolidated			14	860,000		860,000
Utah			30	1,630,000		1,630,000
Vancouver			3	35,000		35,000
Vermont Consolidated			2	44,000		44,000
Ward			5	198,000		198,000
Wells Fargo			14	284,600		284,600
Woodville Consolidated			6	630,000		630,000
Yellow Jacket	25	2,184,000	37	4,638,000		2,454,000
BODIE MINES	23	1,225,000	180	2,671,500	$1,150,000	2,596,500
Addenda			3	60,000		60,000
Aurora tunnel			4	39,000		39,000
Bechtel Consolidated			4	75,000		75,000
Belvidere			6	93,000		93,000
Black Hawk			8	112,500		112,500
Bodie Consolidated	8	400,000	2	75,000	325,000	
Booker Consolidated			5	130,000		130,000
Bulwer Consolidated			1	30,000		30,000
Champion			6	145,000		145,000
Chieftain			2	15,000		15,000
Concordia			2	15,000		15,000
Consolidated Pacific			1	60,000		60,000
Cresus			2	7,500		7,500
Defiance			5	70,000		70,000
Double Standard			3	22,500		22,500
Dudley			8	144,000		144,000
Glyndale Consolidated			1	25,000		25,000
Goodahaw			6	105,000		105,000
Ida			1	15,000		15,000
Jupiter			8	134,000		134,000
Maybell Consolidated			4	30,000		30,000
McClinton			5	90,000		90,000
Mono			7	225,000		225,000
Noonday			2	18,000		18,000
North Noonday			2	27,000		27,000
Orient			3	50,000		50,000
Oro			4	32,000		32,000
Queen Bee			6	46,000		46,000
Red Cloud Consolidated			7	105,000		105,000
Richter			3	50,000		50,000
Riqueza			1	5,000		5,000
Rough and Ready Consolidated			1	5,000		5,000
Rustler			1	6,000		6,000
Santa Mina			1	7,500		7,500
South Bodie			8	50,000		50,000
South Bulwer			7	145,000		145,000
South Standard			6	87,500		87,500
Standard Consolidated	15	825,000			825,000	
Summit			5	90,000		90,000
Tioga Consolidated			9	175,000		175,000
University			5	55,000		55,000
NEVADA (excepting Washoe)	187	12,221,499	327	8,613,561	9,745,000	6,137,063
Adams Hill Consolidated			10	99,500		99,500
Albion Consolidated			2	30,000		30,000
American Flag			10	300,000		300,000
Argenta	2	40,000	5	100,000		60,000
Atlas			1	10,000		10,000
Belle Isle	6	300,000	1	30,000	270,000	
Belmont			24	615,000		615,000
Columbia Consolidated			1	25,000		25,000
Day			6	85,000		85,000
DeFrees			10	140,000		140,000
Eagle			14	210,000		210,000
East Mount Diablo			1	10,000		10,000
El Dorado South Consolidated			13	587,500		587,500
Endowment			4	125,000		125,000
Eureka Consolidated	55	4,230,000	2	100,000	4,230,000	
Fourth of July			2	20,000		20,000
General Thomas			5	100,000		100,000
Gila	2	50,000	7	178,000		128,000
Grand Prize	4	400,000	3	225,000	175,000	
Hamburg			7	305,000		305,000
Hillside			3	110,000		110,000
Hussey Consolidated			9	140,000		140,000
Independence	9	225,000	6	135,000	90,000	
Indian Queen	6	102,000	2	12,000	90,000	
Jackson			11	237,500		237,500

TABLE XII.—DEEP MINES; FINANCIAL SHOWING OF MINING COMPANIES, ETC.—Continued.

Company.	Dividends.		Assessments.		Profit.	Loss.
	No.	Amount.	No.	Amount.		
K. K. Consolidated	*4	$50,000	9	$450,00		$400,000
Leopard	6	162,500	13	372,500		210,000
Manhattan	7	400,000	3	150,000		
Martin White	3	90,000	6	750,000	$250,000	
Meadow Valley	17	1,260,000	15	480,000	780,000	600,000
Metallic			2	25,000		25,000
Monitor-Belmont	3	75,000	7	162,500		87,500
Mount Diablo			2	37,500		37,500
Mount Potosi Consolidated			3	50,000		50,000
Navajo			6	• 155,000		155,000
North Belle Isle			2	25,000		25,000
Northern Belle						
Original Hidden Treasure	31	1,525,000			1,525,000	
Panther	1	31,000	11	330,061		299,062
Paradise Valley			11	87,500		87,500
			1	25,000		25,000
Phœnix			22			
Pleiades			2	10,000		10,000
Raymond & Ely	23	3,675,000	14	740,000	2,935,000	
Real del Monte			10	355,000		355,000
Rye Patch Consolidated	9	105,000	7	157,500		52,500
Silver Prize			4	65,000		65,000
Star			3	180,000		180,000
Tuscarora			5	50,000		50,000
Young America			10	94,500		94,500
CALIFORNIA (excepting Bodie)	39	584,000	33	1,542,500	486,500	1,443,000
Comanche	4	47,500	3	100,000		52,500
Consolidated Amador	34	486,500			486,500	
Mammoth			4	275,000		275,000
Modoc Consolidated	1	50,000	9	600,000		550,000
New Coso			10	490,000		490,000
Oriental Consolidated			6	112,500		112,500
South Modoc			1	25,000		25,000
DAKOTA	17	510,000	16	840,000	310,000	640,000
Caledonia			7	290,000		290,000
Giant and Old Abe			4	200,000		200,000
Golden Terra			3	150,000		150,000
Homestake	17	510,000	2	200,000	310,000	
ARIZONA	9	450,000	5	195,000	450,000	195,000
San Xavier			1	25,000		25,000
Silver King	9	450,000			450,000	
Tip-Top			4	170,000		170,000
IDAHO	13	500,000	24	890,000		390,000
Florida Hill			2	20,000		20,000
Golden Chariot	13	500,000	22	870,000		370,000
UTAH	7	78,000	1	6,000	72,000	
Leeds	7	78,000	1	6,000	72,000	
SCATTERED			7	111,750		111,750
Revenue			1	50,000		50,000
Silver West Consolidated			6	61,750		61,750

RECAPITULATION.

Location of mine.	Dividends.		Assessments.		Net profit.	Net loss.
	No.	Amount.	No.	Amount.		
Total	694	$131,429,599	1,068	$76,585,848	$68,000,503	$3,236,750
Washoe	399	115,871,100	1,000	61,715,535	54,155,565	
Nevada (excepting Washoe)	187	12,221,499	327	8,613,561	3,607,938	
Bodie	23	1,225,000	168	2,671,500		1,446,500
California (excepting Bodie)	39	584,000	33	1,542,500		958,500
Dakota	17	510,000	16	840,000		330,000
Arizona	9	450,000	5	195,000	255,000	
Idaho	13	500,000	24	890,000		390,000
Utah	7	78,000	1	6,000	72,000	
Scattered			7	111,750		111,750

Total dividends	$131,429,599
Total assessments	76,585,848
Total net profits	54,843,751

ANALYSIS OF FINANCIAL SHOWING OF MINING COMPANIES WHOSE STOCKS WERE DEALT IN AT THE SAN FRANCISCO BOARDS AT CLOSE OF CENSUS YEAR.

Location of mine.	Total number of companies reported.	Number showing excess in amount of dividends over assessments.	Number showing excess in amount of assessments over dividends.	Number which have paid dividends.	Number which have levied assessments.	Number which have paid dividends and levied no assessments.	Number which have levied assessments and paid no dividends.	Number which have paid dividends and levied assessments.
Total	212	21	191	40	207	5	172	35
Washoe	103	6	97	14	102	1	89	13
Nevada (excepting Washoe)	49	9	40	17	48	1	32	16
Bodie	41	2	39	2	40	1	39	1
California (excepting Bodie)	7	1	6	3	6	1	4	2
Dakota	4	1	3	1	4	.....	3	1
Arizona	3	1	2	1	2	1	2	.....
Idaho	2	.....	2	1	2	.....	1	1
Utah	1	1	.....	1	1	.....	.....	1
Scattered	2	.....	2	.....	2	.....	2	.....

This table shows the entire number of dividends and assessments of the respective mines, not merely those paid or levied within the census year, but it includes only those mines the shares of which were on the San Francisco stock boards at the close of the census year, and even of these a very large proportion were merely nominally on the market, being very seldom quoted or even practically abandoned, though not stricken from the lists. The table does not show the whole results of the mining business, or even of all the incorporated companies, many of the best and best known of these, such as the Black Bear, the Idaho, and others, as well as the unincorporated mines, not being publicly dealt in. It does not even show the whole business of the mines named in the table, for when the stock of a mine is watered or segregated, or when it is renamed, its record is often lost. Large numbers of mines have also been dropped from the lists, some of which, such as the Poorman, Golden Chariot, Cedarberg, and others, formerly paid dividends, while many others which have now disappeared from the lists once levied large assessments.

In considering the profits and losses of the mining business, it must be remembered that the brilliant possibilities attending it attract a great number of persons who would enter no less speculative occupation so ill provided with the requisite knowledge. An immense number of mines are opened where no experienced mining man would dream of finding remunerative ore, and mines are also sometimes started with the deliberate purpose of swindling the public, or, with fair prospects, are intentionally mismanaged for the same purpose. In short, the profits of mining as a legitimate industry bear a far higher ratio to the expense than would appear from tables which include the cost of the wild ventures and of the deliberate swindles placed upon the market.

In discussing the profits of the mining industry fallacious arguments are often advanced, though the subject is in reality one of great simplicity. A profitless industry is one which pays nobody, or where the actual costs equal or exceed the actual returns. A mine which pays no dividends, but yields sufficient product to settle its accounts for wages and supplies, is not profitless. Agriculture in many regions does no more than support those engaged in it; yet no one would maintain for a moment that a country capable of supporting a given number of persons by farming, even though they were unable to accumulate a surplus, was not by so much richer than a country capable of affording a livelihood to no one. The wages of miners are among the profits of the mining industry; so, too, is the surplus over actual cost of the industries which depend upon the mines for a market and that of the industries which depend upon the mines for supplies. The loss which would ensue if the mines were to be suddenly wiped out of existence is the exact measure of the profit which is now derived from them. In short, the entire profit of the precious-metal mining industry is the entire product in dollars, plus the increment (if any) of the value of mining property, plus the net profit of manufacturers of supplies used in the mines and of wares of the bullion produced; minus the net cost of supplies, including plant consumed in mining, and minus the shrinkage (if any) of the total value of mining property. The increment and decrement in the value of mining property (plant being counted under the head of supplies) can only be measured by the yield of the mines, which fluctuates greatly, but on the whole increases at an average rate of, say, two millions a year. The gross expenditure for supplies other than plant is, say, ten millions, of which perhaps 25 per cent. may be counted as profit, and a similar sum probably represents the profits on the bullion in the manufacture of wares. If the yearly cost of plant is placed at $8,000,000, which is a very rough but probably fair estimate, the profit and loss account of the precious-metal deep mining industry would stand as follows:

Profit.		Loss.	
Product census year	$62,730,000	Net cost of supplies	$7,500,000
Increment in value of mining property	2,000,000	Net cost of plant	6,000,000
Net profit on plant	2,000,000	Profit	58,230,000
Net profit on other supplies	2,500,000		
Net profit on manufacture of bullion ware	2,500,000		
	71,730,000		71,730,000

In fact, the country is as well off as if, there being no deep precious-metal mines, about $58,000,000 from some foreign source were distributed among the men now employed in mining, in the production of mine supplies, and in the manufacture of wares of bullion, these men, of course, being supposed not to earn any more in industries unconnected with mining than they now do.

The question of profit to owners, as such, of deep-mining property is entirely another matter, and is capable only of extremely rough calculation. If the wages of the miners are estimated at $30,000,000 and the annual cost of plant and other supplies at $18,000,000, about $15,000,000 will be left for dividends, besides the appreciation in the total value of mining property, or a gross profit to investors of about $17,000,000, or about 27 per cent. of the product. This estimate is certainly not accurate, but is believed to be within a couple of millions of the truth. This, however, is not all net profit, for owners of mining property who are not personally engaged in working the mines, and this is of course the larger number, commonly purchase them of prospectors or middle men, or of other investors of their own class. The purchase money is not lost to the country, since it merely changes hands; but as the mines are sooner or later exhausted, this money is eventually lost to the investing class. A mine to be profitable to its owners must pay dividends exceeding the price given for it, and if the property changes hands repeatedly the entire amount of dividends must exceed the highest price ever paid for it, for otherwise it must withdraw from other uses more capital than it yields in return. To ascertain the net profits of the class of investors in the deep precious-metal mines of the country there should therefore be deducted from the gross profit, estimated at $17,000,000, the sum annually expended in purchase at the highest rates. It is utterly impossible to say what this sum is, but it can readily be shown to be a large one. Any estimate of the maximum price at which the mines have changed hands based upon the transactions of the stock boards would be extravagant, because these represent sales of a few shares only; but it seems safe to assume that the actual maximum transfers have been at prices at least equaling the amount of the product of the mines for a single year. If the average life of a mine is ten years, one-tenth of the annual product, or over $6,000,000, would have to be deducted from the annual gross profit to obtain the annual net profit of the deep precious-metal mines to the owners.

DEVELOPMENT, ITS NATURE AND EXTENT.

TABLE XIII.—DEEP MINES: MANNER OF OPENING.

State or territory.	Number of mines reported.	Shaft.	Incline.	Shaft and incline.	Shaft and tunnel.	Shaft, incline, and tunnel.	Shaft and open cut.	Shaft, incline, and open cut.	Shaft, tunnel, and open cut.	Shaft, incline, tunnel, and open cut.	Tunnel.	Tunnel and incline.	Tunnel and open cut.	Incline and open cut.	Incline, tunnel, and open cut.	Open cut.
Total	930	195	86	91	202	40	12	1	12	2	151	49	20	6	3	50
Alabama	2					1					1					
Arizona	61	7	14	15	4	4	1	1			1	12		1		1
California	85	23	17	9	7	1					21	7				
Colorado	251	67	15	15	86	11	3		2		43	3		3		3
Dakota	58	5			17	1	5		9	1	12		7		1	
Georgia	10	1			6	2						1				
Idaho	134	13	3	1	17		2		1	1	32	4	13	1	1	45
Maine	11	6	1	1	2										1	
Montana	60	14	18	12	11		1				6	6		1		
Nevada	104	34	7	22	21	5					19	5				
New Hampshire	3				1							1				1
New Mexico	13	4		2	5	1						1				
North Carolina	12	6	1	2	2	1										
Oregon	9		1		3						4	1				
Utah	80	7	5	11	18	12					19	8				
Virginia	5	2		1	1						1					
Washington	1										1					
Wyoming	12	6	4		1	1										

Opening a mine by a tunnel involves the expenditure of less capital than sinking a shaft does. It is therefore a natural method of prospecting. Before mining machinery had reached the perfection which it has attained during the last few decades it was often the only practicable method of draining and working even large and profitable properties. Of late years, however, this method of opening mines has been less and less practiced all over the world. The cases reported in the table as opened by shaft and tunnel are seldom those where tunnels have been run for drainage, but almost always those which have been opened as prospects by tunnel, a shaft having afterward been sunk; and the figures show that less than a quarter of the whole number of mines are practically worked by tunnels. In Nevada, where mining is carried to greater perfection than in most of the

states, only one-sixth of the mines are worked by tunnels. Had the standard of mines reported upon been lower, the proportion of tunnel mines would have been far greater, and, *per contra*, had the standard been higher there would have been a greater proportion of shaft mines.

In very small mines an incline is sometimes sunk on the dip of the vein for prospecting purposes, but these are usually only temporary. In larger mines, those for example on the Comstock lode, an incline is often run on the dip of the vein from the bottom of a vertical shaft when for any reason it is undesirable to penetrate the foot wall. This method, however, has many inconveniences, and of late many engineers prefer under such circumstances to cross-cut into the hanging country rock to a suitable distance and sink a blind shaft vertically to a lower level. The hoisting in the blind shaft, however, must then be done by a compressed-air engine.

Open cuts, excepting for prospecting purposes, are rare, except in Idaho, where the Custer and other mines show large bodies of quartz exposed by erosion, and therefore capable of this simple method of working.

TABLE XIV.—DEEP MINES: EXTENT OF WORKINGS.

State or territory.	Mines reported.	Total length of shafts and inclines.	Total length of tunnels and galleries.	Total length of winzes and upraises.	Greatest depth of workings (vertical).	Greatest horizontal development.
	Number.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
The United States	885	399,686	1,992,191	222,017	3,027	4,000
Alabama	2	480	1,100	30	60	600
Arizona	61	42,058	76,714	2,900	450	1,110
California	88	63,777	253,911	48,984	1,530	3,764
Colorado	251	86,216	279,818	24,742	1,075	2,400
Dakota	57	4,218	27,166	914	300	1,100
Georgia	9	1,546	4,177	87	138	600
Idaho	84	7,086½	61,976	13,388	900	3,200
Maine	11	1,536	1,587	80	245	500
Montana	68	17,809½	61,459	6,986	700	3,000
Nevada	111	119,547	994,914	100,133	3,027	4,000
New Hampshire	3	435	278	.....	280	250
New Mexico	13	4,133	23,997	358	170	800
North Carolina	12	2,876	4,245	328	332	900
Oregon	9	1,631	12,661	2,067	576	1,200
Utah	88	43,108	178,593	20,446	1,600	2,350
Virginia	5	978	5,241	344	142	1,610
Washington	1	.....	159	.....	40	159
Wyoming	12	2,231	4,195	230	210	1,000

The totals in miles, neglecting fractions, would be as follows:

	Miles.
Total length of shafts and inclines	76
Total length of tunnels and galleries	377
Total length of winzes and upraises	42
Total	495

The heading "tunnels and galleries" includes all horizontal workings, known as adits, tunnels, levels, drifts, cross-cuts, etc. The shafts have from one to five compartments, and these are from 3 by 4 feet to 6 by 7 feet in the clear, or between timbers. The tunnels vary from 3½ by 5½ feet to 12 by 9 feet in the clear, with a correspondingly increased total cross-section of excavation if timbered. The winzes seldom have more than one compartment, and are usually smaller than the main shafts.

The figures given in the tables are all taken from the schedules, except in the case of the Comstock lode, the galleries on the mine maps of which were measured by scale. It is probable that the totals represent three quarters of the entire length of mine workings in the deep precious-metal mines of the country which were in operation in the census year.

Under "greatest horizontal development" it was intended that data should be collected as to the extreme extent of any one level in the mines; but some of the experts confined their inquiries to the greatest horizontal extent of the workings on the strike of the deposit, which, however, is usually the same thing. In a few cases of shallow mines surface workings are included in statements as to the greatest horizontal development. Taken together, these tables indicate the extent of the mines, all of which it must be remembered have been opened within about 25 years, and most of them within a shorter period.

TABLE XV.—DEEP MINES: MAXIMUM DEPTH OF WORKINGS.

[NOTE.—Mines less than 500 feet in depth from surface omitted.]

CALIFORNIA.

County and district.	Mine.	Greatest vertical depth below surface.
		Feet.
AMADOR.		
Amador City	Keystone Consolidated	728
Do	Original Amador	780
Jackson	Oneida	1,000
Do	Zeile	500
Plymouth	Empire	1,090
CALAVERAS.		
Mokelumne Hill	Gwin	1,200
Washington	Amelia	500
EL DORADO.		
Placerville	Placerville	600
Springfield, or Mud Springs	Springfield	800
INYO.		
Cerro Gordo	Union Consolidated	900
Lookout	Modoc	1,100
MARIPOSA.		
Mariposa Estate	Hite	700
Do	South Hite	500
MONO.		
Blind Spring	Diana	765
Bodie	Addenda	520
Do	Bechtel Consolidated	625
Do	Belvidere	580
Do	Black Hawk	700
Do	Bodie Consolidated	765
Do	Booker Consolidated	500
Do	Champion	600
Do	Consolidated Pacific	600
Do	Dudley	500
Do	Goodshaw	600
Do	Jupiter	628
Do	McClinton	630
Do	Noonday	512
Do	North Noonday	512
Do	South Bodie	520
Do	South Bulwer	550
Do	South Standard	550
Do	Standard Consolidated	900
Do	Syndicate	800
Do	Tioga Consolidated	800
Do	University	634
NEVADA.		
Grass Valley	Idaho Quartz	1,150
Do	New York Hill	a 1,300
Nevada City	Providence	850
PLACER.		
Colfax	Rising Sun	916
PLUMAS.		
Indian Valley	Green Mountain	1,400
Do	Plumas-National	800
Quartz township	Plumas-Eureka	1,530
SISKIYOU.		
Sawyer's Bar	Klamath	567
South Fork Salmon	Black Bear	515
TUOLUMNE.		
Soulsbyville	Soulsby	630

COLORADO.

BOULDER.		
Gold Hill	American	500
Do	Melvina	500
Grand Island	Cariboo	860
Do	Native Silver	520
CLEAR CREEK.		
Downieville	Red Elephant	540
Griffith	Dunderberg	540
Do	Equator	558
CUSTER.		
	Humboldt	620
GILPIN.		
Eureka	Gunnell	840
Gregory	Bobtail	1,040
Do	New York and Colorado	840
Do	United Gregory	920
GILPIN—continued.		
Nevada	California	1,075
Do	Hidden Treasure	968
Do	Kansas	1,034
Do	Kansas lode	740
Do	Kent County	689
Do	Lacrosse	600
Do	Ralls County	530
Do	West Flack	754
OURAY.		
Upper San Miguel	Alta	500
SAN JUAN.		
Animas	Aspen	500
Do	Highland Mary	b 800
Do	North Star	b 840
Eureka	Bonanza tunnel	b 500

IDAHO.

ALTURAS.		
Middle Boisé	Buffalo	518
Do	Buffalo and Atlanta	b 900
OWYHEE.		
Carson	Empire	762
Do	War Eagle	785

MONTANA.

BEAVER HEAD.		
Trapper	Hecla Consolidated	b 700
DEER LODGE.		
Summit Valley	Alice	500

NEVADA.

ELKO.		
Tuscarora	Argenta	520
Do	Grand Prize	608
Do	Independence	520
ESMERALDA.		
Columbus	Mount Potosi	b 500
Do	Northern Belle	a 1,900
Do	Victor	600
Esmeralda	Real del Monte	880
EUREKA.		
Eureka	Albion	522
Do	Eureka Consolidated	1,240
Do	Hamburg	850
EUREKA—continued.		
Eureka	Jackson	680
Do	Phœnix	700
Do	Richmond	1,025
LANDER.		
Reese River	Curtis	900
LINCOLN.		
Ely	Meadow Valley	1,200
Do	Raymond & Ely	1,480
NYE.		
Philadelphia	Belmont	500
Union	Great American Rooster	a 650

a Measured on dip or incline.

b Greatest depth below surface in tunnel or winze.

TABLE XV.—DEEP MINES: MAXIMUM DEPTH OF WORKINGS.

NEVADA—Continued.

County and district.	Mine.	Greatest vertical depth below surface.	County and district.	Mine.	Greatest vertical depth below surface.
STOREY.		*Feet.*	STOREY—continued.		*Feet.*
American Flat	Baltimore Consolidated	1,450	Virginia	Consolidated Virginia	2,524
Gold Hill	Alta	2,050	Do	Gould & Curry	1,900
Do	Belcher	3,000	Do	Hale & Norcross	2,250
Do	Belcher and Crown Point pump shaft.	3,000	Do	Mexican	2,650
			Do	Mint	1,425
Do	Caledonia	1,900	Do	Ophir	2,540
Do	Consolidated Imperial	3,000	Do	Osbiston shaft	1,960
Do	Crown Point	3,000	Do	Potosi	2,500
Do	Forman shaft	a 1,255	Do	Savage	2,300
Do	Justice	1,375	Do	Scorpion	500
Do	New York	1,850	Do	Sierra Nevada	2,500
Do	Overman	1,900	Do	Union Consolidated	2,500
Do	Silver Hill	1,600	Do	Union shaft	2,600
Do	Yellow Jacket	3,027	Do	Utah	1,350
Virginia	Andes	520	Do	Ward shaft (Bullion)	2,480
Do	Best & Belcher	2,300	WHITE PINE.		
Do	C. N. S. shaft	2,500	Cherry Creek	Star	540
Do	California	2,524	White Pine	Eberhardt & Aurora	1,100
Do	Chollar	2,500			

OREGON.

BAKER.					
Conner Creek	Conner Creek	b 576			

UTAH.

JUAB.			SUMMIT.		
Tintic	Eureka Hill	680	Uinta	Ontario	720
Do	Swansea	650	TOOELE.		
SALT LAKE.			Ophir	Hidden Treasure	1,600
Big Cottonwood	Butte	850	Do	Kearsarge	945
Do	Colboth tunnel	b 600	Do	Queen of the Hill	1,400
Do	Reed & Benson	b 1,000	Rush Valley	Great Basin	840
Little Cottonwood	City Rock	b 700	Do	First National	510
Do	Emma	500	UTAH.		
Do	Vallejo	b 700	American Fork	Miller	b 600
West Mountain	Last Chance	650			
Do	Tiewaukee	b 600			
Do	Winnamuck	b 750			
Do	Yosemite	600			

a Depth June 1, 1880. Depth May 1, 1881, 1,080 feet.

b Greatest depth below surface in tunnel or winze.

To give the development data of all the mines would take too much space, but as the depth reached is an interesting and significant feature, this datum is given in Table XV for those mines which have reached 500 feet below the surface. This table is nearly complete so far as mines worked during the census year is concerned, though there are many abandoned shafts which would come within the limits. It will be observed that, except on the Comstock lode, there are no mines over 2,000 feet in depth. Several Comstock mines have reached 3,000 feet, and are among the deepest mines of the world. The Adalbert shaft at Pribram, in Bohemia, is 1,020$\frac{1}{10}$ meters, or 3,350 feet, in depth, and is the deepest vertical shaft in existence. But while mining on the Comstock began in 1859, the Pribram mines were opened in 1527 and have been worked more or less actively ever since.

TABLE XVI.—COMSTOCK MINES: LENGTH OF DRIFTS, CROSS-CUTS, SHAFTS, INCLINES, AND WINZES.

Mine.	Tunnels, drifts, and cross-cuts.	Shafts.	Inclines.	Winzes.	Total.	Mine.	Tunnels, drifts, and cross-cuts.	Shafts.	Inclines.	Winzes.	Total.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Total	658,994	51,251	28,240	59,742	798,227	Hale & Norcross	26,500	1,788	2,270	3,625	34,183
						Julia	b 5,000	1,775		700	7,475
Alpha	3,625			1,334	4,959	Justice	26,310	1,199	1,920	3,395	32,824
Alta and Benton	7,560	1,509	900	100	10,069	Kentuck	3,340	736		500	4,566
Andes	3,000	520			3,520	Mexican	10,095			1,435	11,530
Baltimore Consolidated	6,600	738	1,100	552	8,990	Mint	6,000	1,425		200	7,625
Belcher	43,320	2,056	5,700	1,230	52,306	New York	4,000	1,200	820		6,020
						Ophir	39,830	2,553	1,700	4,620	48,703
Best & Belcher	14,400	479		977	15,856	Original Keystone		436			436
Bullion	14,025	3,200	2,000	830	20,055	Overman and Caledonia	50,900	4,145		3,760	58,895
California	28,190	a 2,384		3,553	34,127	Savage	41,800	1,906	1,900	2,742	48,348
Chollar-Potosi	56,400	2,899	1,300	4,300	64,899	Scorpion	2,050	500			2,550
Confidence	6,600			580	7,180						
						Sierra Nevada	31,820	2,600	1,900	2,582	38,902
Consolidated Imperial	14,600	1,300	1,100	2,933	19,933	Silver Hill	21,450	444	1,500	867	24,261
Consolidated Virginia	27,975	2,531		2,007	32,513	Sutro tunnel	29,899				29,899
Crown Point	31,195	980	1,800	3,100	37,075	Union Consolidated	9,010	2,604		950	12,564
Exchequer	2,550				2,550	Utah	7,790	1,338	1,280	210	10,568
Gould & Curry	37,650	3,197	500	5,150	46,497	Yellow Jacket	45,420	4,819		7,510	57,749

a C. & C. joint shaft.

b Estimated.

This table includes only those shafts, galleries, etc., which have been surveyed. In the Comstock mines all important workings are now run by survey and are duly recorded, but in the early days many drifts were not thus laid out, and unimportant galleries are still occasionally run without the assistance of the surveyor, and thus escape plotting. After consultations with the superintendents and surveyors, the unsurveyed workings have been estimated as follows:

	Feet.
Shafts (10 per cent. additional)	5,125
Inclines (10 per cent. additional)	2,824
Winzes (10 per cent. additional)	5,974
Tunnels, drifts, and cross-cuts (25 per cent. additional)	164,748
	178,671
Add total accounted for	798,227
Probable total	976,898

This would be 185 miles and 98 feet.

	Feet.
The average size of drifts is	6 by 7
The average size of single winzes	6 by 7
The average size of double winzes	12 by 7
The average size of shafts (in the clear)	5½ by 15
Area of excavation of the Forman shaft	8½ by 28
Area of excavation of the Combination shaft	9 by 28
Area of excavation of the Yellow Jacket new shaft	9½ by 23
Area of excavation of the Osbiston shaft	8½ by 23
Area of excavation of the old shafts (average)	8 by 20

TABLE XVII.—DEEP MINES: DIMENSIONS OF SOME OF THE LONG TUNNELS OF THE WORLD.

[From data prepared by John D. Barry, M. E.]

Name of tunnel.	Country.	Length.	Width.	Height.
		Feet.	*Feet.*	*Feet.*
Hoosac	United States	24,416	26	22½
Musconetcong	do	4,879	26	21
Sutro (including laterals)	do	29,297	10 to 12	8 to 9
Nesquehoning	do	3,890	16	19
Allegheny	do	4,711	26	19.50
Sandidge	England	16,035	.....	.....
New Sandidge	do	16,305	.....	.....
Leeds	do	11,119	.....	.....
Rilly	France	11,319	24.20	19.2
Nerthe	do	15,220	26.20	24.50
Saint Martin	do	31,326	26.20	18
Blaisy	do	13,452	26.25	26.25
Bildstock	Germany	18,915	.....	.....
Frejus	France	12,833	.....	.....
Saint Gothard	Switzerland	48,887	.....	.....
Dudley Canal	England	11,328	.....	.....
Huddersfield Canal	do	16,650	.....	.....
Kennel and Avon Canal	do	13,200	.....	.....
Pensar Canal	do	11,550	.....	.....
Thames and Medway	do	11,880	30	38
Thames and Severn Canal	do	12,540	15	15
Sierra Madre	Mexico	63,390	.....	.....
San Carlos and Union Pacific		13,200	.....	.....
Severn tunnel	England	23,760	.....	.....
Wochtestongo	Mexico	21,659	11	13
Ernst August	Germany	71,280	.....	.....
Georg tunnel	do	56,760	.....	.....
Joseph II, Schemnitz	do	48,840	.....	.....
Mont Cenis	France, Italy	40,138	.....	.....

TABLE XVIII.—DEEP MINES: STEAM HOISTING ENGINES.

ARIZONA.

County and district.	Mine.	Number of hoisting engines.	Number in use.	Total horse-power.	Remarks.
MARICOPA.					
Globe	Mack Morris	1	1	12	Horizontal, without fly-wheel; geared. (a)
Do	Silver Nugget	1	1	10	Horizontal.
Do	Stonewall	1	1	12	Horizontal, with fly-wheel; geared.
	Vulture	1	1	30	Horizontal, without fly-wheel; geared 6 to 1. (a)
MOHAVE.					
Hualapai	Keystone	1	1	8	Donkey.
Do	Lone Star	1		10	Horizontal, with fly-wheel.
PIMA.					
Arivaca	Consolidated Arizona	1		20	Horizontal, with fly-wheel; link-motion.
Tombstone	Contention	1	1	20	Horizontal, without fly-wheel; geared. (a)
Do	Empire	1	1	40	Horizontal, without fly-wheel; geared.
Do	Grand Central	1	1	25	Horizontal, without fly-wheel; geared.
Do	Sulphuret	1	1	25	Horizontal, without fly-wheel; geared 2 to 1; coupled.
Do	Toughnut and Goodenough	2	2	30	Horizontal, without fly-wheel; geared; main shaft, 20 horse-power; northwest shaft, 10 horse-power.
Do	Toughnut Extension	1	1	25	Horizontal, with fly-wheel; geared 8 to 1.
PINAL.					
Pioneer	Silver King	1	1	30	Horizontal, without fly-wheel; geared 12 to 1.
YAVAPAI.					
Humbug	Tip-Top	1	1	12	Horizontal, with fly-wheel.
Tiger	Tiger	1	1	60	Horizontal, with fly-wheel; geared 5 to 1.

CALIFORNIA.

AMADOR.					
Amador City	Keystone Consolidated	2	2	120	One vertical, 80 horse-power; one horizontal, 40 horse-power, coupled, with fly-wheel.
Do	Original Amador	1	1	40	Horizontal, coupled, with fly-wheel.
Jackson	Monte Richard	1	1	25	Horizontal, with fly-wheel.
Do	Oneida	3	3	50	Horizontal, with fly-wheel; coupled.
Do	Zelle	1	1	75	Horizontal, with fly-wheel; coupled.
Plymouth	Empire	2	2	80	Horizontal, with fly-wheel; coupled.
Do	Pacific	2		70	
Sutter Creek	Consolidated Amador	1	1	60	Horizontal, coupled, with fly-wheel.
Volcano	Downs	1	1	40	
CALAVERAS.					
Washington	Amelia	2	2	30	Horizontal, coupled, with fly-wheel.
EL DORADO.					
Placerville	Placerville	1	1	35	Horizontal, coupled, with fly-wheel.
Springfield, or Mud Springs	Springfield	1	1	30	Horizontal, coupled, with fly-wheel.
	Chapparal	1	1	10	
INYO.					
Cerro Gordo	Union Consolidated	2	2	65	Horizontal surface hoisting engine, 40 horse-power; underground engine, 25 horse-power.
Coso	Lucky Jim	1		20	Vertical.
Lookout	Modoc and others	1	1	12	Vertical.
MARIPOSA.					
Hornitos	Washington	2	2	75	Horizontal, coupled, with fly-wheel.
Mariposa Estate	Ferguson	1	1	18	Horizontal, coupled, with fly-wheel.
Do	Mariposa tunnel and Sucredo	1	1	b 30	Horizontal, coupled, with fly-wheel (compressed air).
	Yosemite	1	1	25	
MONO.					
Blind Spring	Diana and Kerrick	1	1	25	Horizontal, coupled, without fly-wheel.
Bodie	Addenda	1	1	20	Horizontal, coupled, with fly-wheel.
Do	Bechtel Consolidated	1	1	b 20	Donkey engine.
Do	Belvidere	1	1	b 60	Horizontal, coupled, without fly-wheel.
Do	Black Hawk	1	1	20	Donkey.
Do	Bodie Consolidated	2	2	30	Horizontal, coupled, without fly-wheel.
Do	Booker Consolidated	1	1	40	Horizontal, coupled, with fly-wheel.
Do	Champion	1	1	25	Horizontal, coupled, with fly-wheel.
Do	Consolidated Pacific	1	1	30	Horizontal, coupled, with fly-wheel.
Do	Defiance	1	1	25	Horizontal, coupled, with fly-wheel.
Do	Dudley	1	1	b 30	Vertical, coupled, with fly-wheel.
Do	Goodshaw	1	1	25	Horizontal, coupled, without fly-wheel.
Do	Jupiter	1	1	25	Horizontal, coupled, with fly-wheel.
Do	McClinton	1	1	25	Horizontal, coupled, without fly-wheel.
Do	Maryland Consolidated	1	1	25	Horizontal, without fly-wheel. (a)
Do	Noonday	1	1	40	Horizontal, coupled, without fly-wheel.
Do	Oro	1	1	55	Vertical, coupled, without fly-wheel.
Do	Queen Bee	1	1	60	Horizontal, coupled, without fly-wheel.
Do	South Bodie	1	1	25	Horizontal, coupled, with fly-wheel.
Do	South Bulwer	1	1	30	Horizontal, coupled, with fly-wheel; geared.

a Believed to be a coupled engine, but some single-cylinder engines, the fly-wheels of which are used as pulleys or gears, may be included.
b Estimated horse-power.

TABLE XVIII.—DEEP MINES: STEAM HOISTING ENGINES.

CALIFORNIA—Continued.

County and district.	Mine.	Number of hoisting engines.	Number in use.	Total horse-power.	Remarks.
MONO—continued.					
Bodie	South Standard	1	1	25	Horizontal, without fly-wheel; direct-acting. (a)
Do	Standard Consolidated	2	2	60	Horizontal, coupled, without fly-wheel.
Do	Syndicate	1	1	15	Niles single reel.
Do	Tioga Consolidated	1	1	30	Horizontal, coupled, without fly-wheel.
Do	University	2	2	80	Horizontal, without fly-wheel (compound).
NEVADA.					
Grass Valley	Idaho Quartz	2	2	140	Horizontal, coupled, with fly-wheel.
Do	New York Hill	1	1	25	Horizontal, coupled, with fly-wheel.
Do	Rocky Bar	1	1	25	Horizontal, coupled, with fly-wheel.
Nevada City	Consolidated Wyoming	1	1	20	Horizontal, coupled, with fly-wheel.
Do	Murchie	2	1	65	Horizontal, coupled, with fly-wheel.
Do	Nevada City	1	1	25	Horizontal, coupled, with fly-wheel.
Do	Providence	1	1	30	Horizontal, coupled, with fly-wheel.
PLACER.					
Colfax	Rising Sun	1	1	b 40	Horizontal, coupled, with fly-wheel.
PLUMAS.					
Quarts township	Plumas-Eureka	1	1	12	Horizontal, without fly-wheel.
SISKIYOU.					
South Fork Salmon	Black Bear	1	1	100	Horizontal, coupled, without fly-wheel.
TUOLUMNE.					
Confidence	Confidence	1	1	30	Horizontal, coupled, with fly-wheel.
Soulsbyville	Soulsby	2	2	80	Horizontal, not coupled, with fly-wheel.

COLORADO.

BOULDER.					
Central	Golden Age	1	1	25	
Do	John Jay	1	1	14	
Do	Smuggler	1	1	15	Vertical, geared.
Gold Hill	American	1	1	15	Portable.
Do	Cold Spring	1	1	15	Engine and boiler on same bed.
Do	Melvina	1	1	12	
Do	Slide	1	1	50	Horizontal, with fly-wheel, friction gear.
Do	Victoria & Lincoln	1	1	20	Horizontal, coupled, with fly-wheel, friction gear.
Grand Island	Boulder County & Trojan	1	1	50	Horizontal, with fly-wheel.
Do	Cariboo	3	1	140	Horizontal, with fly-wheel, friction gear.
Do	Horsefall or '59	1	1	40	Single cylinder, with fly-wheel.
Do	Idaho	1	1	25	Horizontal, coupled, with fly-wheel.
Do	Native Silver	1	1	15	Horizontal.
Do	Poorman	1	1	20	Horizontal, coupled.
Do	Seven-thirty	1	1	20	Horizontal, with fly-wheel.
Magnolia	Keystone	1	1	12	Vertical.
Ward	Nelson	1	1	35	Horizontal, coupled, with fly-wheel.
Do	Niwot	1	1	175	Horizontal, coupled, with fly-wheel.
CLEAR CREEK.					
Downieville	Red Elephant	2	2	40	Horizontal, with fly-wheel.
Geneva	Baltic	1	1	25	Horizontal, with fly-wheel; single cylinder, friction gear.
Griffith	Colorado Central Consolidated	2	2	35	One horizontal, coupled, with fly-wheel; one horizontal, not coupled, with fly-wheel; one friction gear, one cog gear.
Do	Consolidated Hercules & Roe	1	1	4	Vertical, not coupled, with fly-wheel; geared.
Do	Dunderberg	2	2	80	Horizontal, coupled, with fly-wheel, one for mine hoisting, one for tramway; both high pressure and geared.
Do	Equator	1	1	20	Horizontal, not coupled, with fly-wheel; friction gear, paper against iron.
Griffith and Queens	Colorado Territory National	2	1	37	Horizontal, with fly-wheel.
Spanish Bar	Hukill	1	1	35	Horizontal, with fly-wheel, coupled.
Do	Mayflower	2	1	40	One horizontal, with fly-wheel, one vertical, with fly-wheel.
Upper Union	Fred. Rogers	1	1	10	Vertical, coupled, with fly-wheel; geared.
Do	Neith	1	1	4	Vertical, not coupled, with fly-wheel; friction gear.
Do	Pioneer	1	1	6	Vertical, without fly-wheel; friction gear. (a)
Virginia	Specie Payment	1	1	8	Vertical, coupled, with fly-wheel.
Do	White Cloud	1	1	25	Horizontal, with fly-wheel; single cylinder.
York	Clifford	1	1	18	Horizontal, without fly-wheel; portable. (a)
CUSTER.					
Hardscrabble	Bull-Domingo	1	1	60	Horizontal, without fly-wheel. (a)
Do	Song Bird & Gray Eagle	1	1	8	Horizontal, with fly-wheel.
Verde	Verde	1	1	20	Horizontal, with fly-wheel.
	Humboldt	2	2	65	Both horizontal, coupled; one has fly-wheel, other has not.
GILPIN.					
Eureka	Gunnell	2	2	115	Horizontal, not coupled, with fly-wheel.
Gregory	Bobtail	2	2	85	Horizontal, coupled, without fly-wheel.
Do	Empress	1	0	20	Horizontal, not coupled, with fly-wheel.
Do	German	1	1	22	Horizontal, not coupled, with fly-wheel.
Do	New York & Colorado	1	1	60	Horizontal, not coupled, with fly-wheel.

a Believed to be a coupled engine, but some single-cylinder engines, the fly-wheels of which are used as pulleys or gears, may be included. b Estimated horse-power.

TABLE XVIII.—DEEP MINES: STEAM HOISTING ENGINES.

COLORADO—Continued.

County and district.	Mine.	Number of hoisting engines.	Number in use.	Total horse-power.	Remarks.
GILPIN—continued.					
Gregory	Smith	1	.....	15	Horizontal, portable.
Do	United Gregory	2	2	152	Horizontal, not coupled, with fly-wheel. One at Briggs shaft, 125 horse-power, runs stamps in addition to hoisting.
Do	Wain	1	1	15	Horizontal, without fly-wheel; portable.
Nevada	American Flag	1	1	35	Horizontal, not coupled, with fly-wheel.
Do	California	1	1	50	Horizontal, coupled, with fly-wheel.
Do	Egyptian	1	1	22	Horizontal, not coupled, with fly-wheel.
Do	Hidden Treasure	1	1	30	Horizontal, not coupled, with fly-wheel.
Do	Jones	1	1	12	Horizontal, not coupled, with fly-wheel.
Do	Kansas	1	1	30	Horizontal, coupled, with fly-wheel.
Do	Kansas lode	1	1	26	Horizontal, not coupled, with fly-wheel.
Do	Kent County	1	1	50	Horizontal, not coupled, with fly-wheel.
Do	Lacrosse	1	1	20	Horizontal, not coupled, without fly-wheel.
Do	Pyrenees	1	1	10	Horizontal, not coupled, with fly-wheel.
Do	Ralls County	1	1	40	Horizontal, not coupled, with fly-wheel.
Do	Sayr-Burroughs	1	1	40	Horizontal, not coupled, with fly-wheel.
Do	West Flack	1	1	25	Horizontal, not coupled, with fly-wheel.
Quarts Valley	Boss	1	1	5	Vertical, with fly-wheel.
Russell	Haseltine	1	1	40	Vertical, without fly-wheel; cylinder 10 by 12.(a)
Do	Leavenworth	1	1	16	Horizontal, with fly-wheel; portable.
Do	Pewabic	2	2	50	Horizontal, with fly-wheel; one portable.
Do	Powers	1	1	10	Horizontal, with fly-wheel; portable.
Do	Wyandotte	1	1	20	Horizontal, not coupled, with fly-wheel.
HINSDALE.					
Galena	Ulay & Ute	2	2	85	Horizontal, coupled.
LAKE.					
California	Adelaide	1	1	25	Horizontal, coupled, with fly-wheel.
Do	Agassiz	1	1	9	Horizontal, coupled, with fly-wheel.
Do	Amie	3	3	49	Two vertical [coupled?], without fly-wheel, one horizontal, with fly-wheel.
Do	Breece Iron	1	1	15	Horizontal, coupled, without fly-wheel.
Do	Catalpa	1	1	25	Vertical, not coupled, with fly-wheel.
Do	Chrysolite	6	5	190	Four vertical, two horizontal, none coupled; all have fly-wheels.
Do	Climax	1	1	15	Vertical, not coupled, with fly-wheel.
Do	Colorado Prince	1	1	10	Vertical, not coupled, with fly-wheel.
Do	Double Decker	1	1	15	Horizontal, not coupled, with fly-wheel.
Do	Dunkin	1	1	7	Vertical, not coupled, with fly-wheel.
Do	Evening Star	2	2	25	Horizontal, without fly-wheel. (a)
Do	Glass-Pendery	2	2	14	Vertical, not coupled, with fly-wheel.
Do	Hibernian	1	1	4	Vertical, without fly-wheel; "baby engine".
Do	Highland Chief	1	1	25	Horizontal, not coupled, with fly-wheel.
Do	Iron	1	1	15	Horizontal, belted to drum.
Do	Leadville Consolidated	2	2	36	One horizontal, one vertical; both have fly-wheel.
Do	Little Chief	5	5	83	Four donkey, one Niles double engine.
Do	Little Pittsburgh	5	5	40	Four vertical, without fly-wheel; one horizontal, with fly-wheel.
Do	Matchless	1	1	30	Horizontal, not coupled, with fly-wheel.
Do	Miner Boy	2	2	25	One horizontal, one vertical, not coupled; both have fly-wheel.
Do	Morning Star	2	2	40	One horizontal, one vertical, not coupled; both have fly-wheel.
Do	Robert E. Lee	2	1	40	Horizontal, double cylinder, without fly-wheel.
Do	Silver Wave	1	1	10	Vertical, with fly-wheel; friction gear.
Do	Virginius	1	1	15	Horizontal, with fly-wheel; single cylinder.
OURAY.					
Uncompahgre	Begola	1	.....	30	Horizontal, single, without fly-wheel. (b)
SAN JUAN.					
Eureka	Adelphi	1	1	5	Vertical, single, without fly-wheel. (b)
SUMMIT.					
Consolidated Ten-mile	Robinson Consolidated	2	2	31	One horizontal, compound friction and clutch gear, with fly-wheel; one "baby" hoist.
DAKOTA.					
LAWRENCE.					
Bear Butte	Escondido	1	1	25	Horizontal, not coupled, without fly-wheel. (b)
Whitewood	Homestake	3	3	110	One 60 horse-power, 12-inch diameter by 30-inch stroke (probably with fly-wheel); one coupled engine with 10- by 12-inch cylinders.
Do	Sir Roderick Dhu	2	2	25	One horizontal, 17 horse-power, with fly-wheel; one vertical, 8 horse-power.

a Believed to be a coupled engine, but some single-cylinder engines, the fly-wheels of which are used as pulleys or gears, may be included.
b Fly-wheel doing duty as gearing.

TABLE XVIII.—DEEP MINES: STEAM HOISTING ENGINES.

County and district.	Mine.	Number of hoisting engines.	Number in use.	Total horse-power.	Remarks.
GEORGIA.					
COBB.					
.....	Kendrick	1	1	12	Horizontal, double cylinder, high pressure, reversible.
FORSYTH.					
Third and Second	Strickland	1	1	12	Horizontal, coupled, without fly-wheel.
HALL.					
Ninth	Harris	1	1	20	Horizontal, single, with fly-wheel.
LINCOLN.					
.....	Magruder	1	1	20	Horizontal, with fly-wheel; single cylinder.
M'DUFFIE.					
Republican	Jennings	1	1	8	Oscillating.
MERIWETHER.					
Lutherville	Wilkes	1	1	40	Horizontal, single, with fly-wheel.
IDAHO.					
ALTURAS.					
Middle Boisé	Buffalo	2	2	25	One horizontal, one vertical; neither has fly-wheel.
BOISÉ.					
Banner	Wolverine	1	1	25	Double-cylinder donkey.
Granite	Gold Hill	2	2	35	Horizontal, without fly-wheel; reels can be run singly, together, or in opposite directions; cylinders set on opposite sides of locomotive boiler.
OWYHEE.					
Carson	Black Jack	1	1	10	Direct-acting vertical donkey engine, with fly-wheel.
Do	Empire	1	1	20	Direct-acting horizontal, with fly-wheel, 15-inch stroke, 64 strokes per minute.
Do	Owyhee	1	1	20	Mounted on horizontal boiler, like portable engine, with fly-wheel.
Do	Potosi	1	1	20	Horizontal, with fly-wheel.
Do	War Eagle	1	1	35	All the machinery now being supplanted by much more powerful.
Wagontown	Golden Rule	1	1	30	Horizontal, with fly-wheel.
MAINE.					
HANCOCK.					
Go'dsboro'	Goldsboro'	1	1	20	Horizontal, without fly-wheel. (a)
Sullivan	Ashley	1	1	25	Horizontal, without fly-wheel, coupled.
Do	Milton	2	2	15	Horizontal.
Do	Waukeag	1	1	15	Horizontal, with fly-wheel.
West Sullivan	Sullivan	2	2	18	One double cylinder, horizontal, 10 horse-power; one single cylinder, vertical, 8 horse-power.
.....	Deer Isle	1	1	15	Horizontal, with fly-wheel.
PENOBSCOT.					
.....	Consolidated Hampden	1	1	16	Double cylinder, vertical, without fly-wheel.
WASHINGTON.					
Fifth	Cherryfield	1	1	15	Double cylinder, horizontal, oscillating.
YORK.					
Acton	Acton Consolidated	1	1	25	Horizontal, without fly-wheel. (a)
MONTANA.					
BEAVER HEAD.					
Trapper	Hecla Consolidated	2	2	28	Two double cylinder, 10 horse-power each, without fly-wheel; one single cylinder, 8 horse-power, with fly-wheel.
DEER LODGE.					
Flint Creek	Algonquin	1	.....	80	Horizontal, without fly-wheel. (a)
Do	Spookied Trout	1	1	25	Horizontal, single, with fly-wheel.
Independence	Mountain Boy	1	1	20	Horizontal.
Silver Creek	Penobscot & Snowdrift	1	1	30	Horizontal, single, with fly-wheel.
Summit	National	1	1	20	Horizontal, coupled, with fly-wheel.
Summit Valley	Alice	2	2	170	Horizontal, coupled, without fly-wheel.
Do	Colusa	1	1	25	Horizontal, double cylinder.
Do	Gagnon	1	1	20	Horizontal, with fly-wheel; high pressure, direct acting.
Do	Morning Star	1	1	20	Horizontal.
JEFFERSON.					
Cedar Plains	Keating	1	1	20	Horizontal, with fly-wheel.
LEWIS AND CLARKE.					
Owyhee	Union No. 2	5	5	140	Horizontal, with fly-wheel; two 15 horse-power, two 25 horse-power, one 60 horse-power.

a Believed to be a coupled engine, but some single-cylinder engines, the fly-wheels of which are used as pulleys or gears, may be included.

TABLE XVIII.—DEEP MINES: STEAM HOISTING ENGINES.

NEVADA.

County and district.	Mine.	Number of hoisting engines.	Number in use.	Total horse-power.	Remarks.
ELKO.					
Tuscarora	Argenta	1	1	30	Double horizontal donkey engine, without fly-wheel; cylinder 8 by 12 inches.
Do	Catskill	1	1	10	Donkey.
Do	Grand Prize	2	1	40	Horizontal, single cylinder, with fly-wheel.
Do	Independence	1	1	20	Horizontal, single cylinder, with fly-wheel.
Do	Navajo	1	1	16	Horizontal, coupled, with fly-wheel, link-motion; cylinder 8 by 16 inches.
Do	North Belle Isle	1	1	15	Horizontal donkey engine, without fly-wheel; cylinder 6½ by 12 inches.
ESMERALDA.					
Black Mountain	Endowment	1	1	12	Vertical.
Columbus	Equator	1	1	120	Horizontal, with fly-wheel.
Do	Metallic	1	1	120	Horizontal, with fly-wheel.
Do	Monte Diablo	1	1	35	Horizontal, coupled.
Do	Northern Belle	1	1	40	Horizontal, coupled, with fly-wheel.
Esmeralda	Real del Monte	1	1	28	Horizontal, coupled, without fly-wheel; 8-inch cylinder.
Wilson	Wilson or Himalaya	1	1	36	Horizontal, with fly-wheel.
EUREKA.					
Cortez	Garrison	1	.....	a 10	Horizontal, coupled, with fly-wheel; 6-inch cylinder, 6-inch stroke.
Eureka	Albion	1	1	70	Double cylinder, 10 by 12 inches.
Do	Dunderberg	1	1	50	Horizontal, single cylinder.
Do	Eureka	4	4	145	
Do	Hamburg	1	1	60	Horizontal, single cylinder; double reel, with clutch on engine-shaft.
Do	Hocsac	1	1	24	Horizontal, single cylinder.
Do	Jackson	1	1	50	Horizontal, coupled.
Do	Kit Carson	1	1	8	Vertical, donkey.
Do	Richmond	2	2	250	Horizontal, coupled with fly-wheel.
Secret Cañon	Geddes & Bertrand	1	1	15	Horizontal, single cylinder; double reel, 16-inch stroke, 10½-inch cylinder.
LANDER.					
Battle Mountain	Ætna	3	3	45	Donkey, 6-inch cylinder, 12-inch stroke.
Lewis	Starr & Grove	1	1	15	Donkey.
Reese River	Curtis	3	3	60	One horizontal with fly-wheel; two donkey engines driven by compressed air.
LINCOLN.					
Bristol	Hillside	1	1	24	Horizontal, with fly-wheel; 10-inch cylinder, 20-inch stroke.
Ely	Raymond & Ely	2	2	a 150	Horizontal, single cylinder, with fly-wheel.
NYE.					
Morey	Morey	1	1	15	Horizontal, coupled, with fly-wheel.
Philadelphia	Belmont	1	1	25	Horizontal, coupled, with fly-wheel.
Tybo	Tybo	1	1	40	Horizontal, with fly-wheel.
Union	Brooklyn	1	1	10	Horizontal, without fly-wheel. (b)
Do	Great American Rooster	1	1	20	Horizontal, coupled.
STOREY.					
American Flat	Baltimore Consolidated	1	.....	a 20	Horizontal, with fly-wheel; geared.
Gold Hill	Alta	2	2	150	Horizontal, double cylinder, direct acting, coupled or uncoupled at will; brake-wheel acts as fly-wheel. Incline engine underground.
Do	Belcher	2	2	140	Horizontal, coupled, with fly-wheel.
Do	Belcher and Crown Point pump-shaft.	1	1	a 60	Horizontal, coupled, with fly-wheel, geared; double cylinder, 16-inch diameter by 24-inch stroke.
Do	Consolidated Imperial	2	2	350	One double-cylinder engine in vertical shaft; one single-cylinder incline engine.
Do	Crown Point	3	3	600	Two vertical shaft engines, independent; cylinders 18-inch diameter by 24-inch stroke. One with two reels, one with one. Incline engine, geared, double cylinders, 30-inch diameter by 42-inch stroke.
Do	Forman shaft	1	1	180	Double cylinder, horizontal, coupled, with fly-wheel.
Do	Justice	2	0	a 70	One vertical shaft engine, double cylinder, 16-inch diameter by 36-inch stroke. One incline engine, double cylinder, 20-inch diameter by 44-inch stroke.
Do	New York	2	2	280	Horizontal, with fly-wheel. One vertical shaft engine, 80 horse-power. One incline shaft engine, 200 horse-power.
Do	Overman	3	3	276	Two single engines, not coupled; one double-cylinder engine, coupled.
Do	Silver Hill	2	2	180	One double-cylinder horizontal engine, coupled, without fly-wheel; one not coupled, with fly-wheel.
Do	Yellow Jacket	2	2	a 2,500	Two horizontal working-compartment engines, 28-inch diameter by 8-foot stroke, 1,000 horse-power each; independent. One pump-compartment engine, 18-inch diameter by 2-foot stroke, 500 horse-power.
Virginia	Andes	1	1	60	Horizontal, coupled, with fly-wheel.
Do	Best & Belcher	1	0	30	Worked through Gobiston shaft.
Do	C. & C. shaft	2	2	a 2,200	Horizontal. Main engine, double cylinder, 36-inch diameter by 6-foot stroke, direct acting; pump-compartment engine, 16-inch diameter by 24-inch stroke, geared. Heavy brake-wheels act as fly-wheels.
Do	C. N. S. shaft	2	2	300	Horizontal, coupled, with fly-wheel; all geared.
Do	Gould & Curry	3	3	250	Horizontal, with fly-wheel; single, geared. Two 100 horse-power each, one 50 horse-power.
Do	Hale & Norcross	2	2	180	Horizontal, with fly-wheel; geared 3½ to 1.
Do	Mint	1	1	25	Horizontal, with fly-wheel.
Do	Ophir	3	3	700	Horizontal. Two vertical shaft-engines, 200 horse-power each; one incline engine, 300 horse-power. All geared. Heavy brake-wheels act as fly-wheels.
Do	Original Keystone	1	1	a 60	Horizontal, with fly-wheel. Geared.

a Estimated horse-power.
b Believed to be a coupled engine, but some single-cylinder engines, the fly-wheels of which are used as pulleys or gears, may be included.
c As reported at mine.

TABLE XVIII.—DEEP MINES: STEAM HOISTING ENGINES.

NEVADA—Continued.

County and district.	Mine.	Number of hoisting engines.	Number in use.	Total horse-power.	Remarks.
STOREY—continued.					
Virginia	Ophiteon shaft	1	1	200	Horizontal, with fly-wheel, geared; double cylinder.
Do	Savage	2	2	800	Horizontal, with fly-wheel, coupled. One vertical shaft engine, 300 horse-power; one incline shaft engine, 600 horse-power; both geared, double cylinder, 24-inch diameter by 4 feet stroke.
Do	Scorpion	1	1	40	Horizontal, double cylinder, geared.
Do	Sierra Nevada	1	.....	150	Horizontal, with fly-wheel. Double cylinder, geared 5 to 1.
Do	Union shaft	2	2	a 1,000	Horizontal; main engine, double cylinder, 1,200 horse-power. Pump-compartment engine, 400 horse-power. Heavy brake-wheels act as fly-wheels.
Do	Utah	2	2	120	Horizontal. One vertical shaft engine, double cylinder, link motion; geared. One incline engine similar.
Do	Ward shaft (Bullion)	2	.....	250	Horizontal, direct acting, with fly-wheel.
WHITE PINE.					
Cherry Creek	Exchange	1	1	30	Horizontal, single.
Do	Star	1	1	30	Horizontal, single, double reel; friction gear.
Do	Tikup	1	1	10	Horizontal. First engine set up on coast; formerly used in Virginia City. Single cylinder, friction gear. Connection between engine and reel by 10-inch belt.
White Pine	Eberhardt & Aurora	1	1	20	Horizontal, coupled, with fly-wheel, 13-inch diameter by 2 feet stroke.

NEW HAMPSHIRE.

COOS.					
Shelburne	Shelburne	1	1	15	Horizontal, coupled.
GRAFTON.					
Ammonoosuc	Little May	1	1	40	

NEW MEXICO.

GRANT.					
Chloride Flat	Bromon	1	1	20	Horizontal, with fly-wheel.
Silver Flat	Massachusetts and New Mexico	1	1	25	Inclined, coupled, with fly-wheel.

NORTH CAROLINA.

DAVIDSON.					
Emmons township	Silver Valley	1	1	25	Oscillating; double cylinder.
	Conrad Hill	1	1	30	Inclined cylinders, coupled, with fly-wheel.
GASTON.					
	King's Mountain	1	1	30	Horizontal, coupled, without fly-wheel.
MECKLENBURG.					
Capp's Hill	McGinn	1	1	40	Horizontal, single, with fly-wheel.
Sixth	Radcliff	1	1	15	Horizontal, with fly-wheel.
MOORE.					
	Healey Hill	1	1	30	Horizontal, coupled, without fly-wheel.
NASH.					
Griffith township	Mann	1	1	15	Horizontal, single, without fly-wheel. (b)
ROWAN.					
	Dunn's Mountain	2	2	24	One horizontal, one vertical. Both have fly-wheels; both single cylinder.
STANLEY.					
	Crowell	1	1	40	Horizontal, coupled, without fly-wheel.

OREGON.

BAKER.					
Rye Valley	Rye Valley	1	1	40	Horizontal, with fly-wheel.
	Virtue	2	2	60	One portable horizontal 10 horse-power, with fly-wheel; one stationary horizontal 50 horse-power, with fly-wheel.

a As reported at mine.

b Fly-wheel doing duty as gearing.

TABLE XVIII.—DEEP MINES: STEAM HOISTING ENGINES.

UTAH.

County and district.	Mine.	Number of hoisting engines.	Number in use.	Total horse-power.	Remarks.
BEAVER.					
San Francisco	Carbonate	1	1	12	Old steamboat engine; double cylinder, rocker valve.
Do	Horn Silver	2	.....	120	Horizontal, without fly-wheel; cylinders, 12 inches diameter by 4 feet stroke; work with clutch or independently.
JUAB.					
Tintic	Locke	1	1	10	Small road engine.
SALT LAKE.					
Big Cottonwood	Antelope & Prince of Wales	2	2	80	One 40 horse-power at surface; one 10 horse-power underground.
Do	Oregon	1	1	8	Vertical.
Little Cottonwood	Flagstaff	1	1	60	Compressed air in tunnel.
Do	Grizzly & Livonia	1	1	12	
Do	Toledo	1	1	a 30	Run by compressed air.
West Mountain	Last Chance	1	1	30	
Do	Queen & Bemis	1	.....	40	Horizontal, coupled, with fly-wheel.
Do	The Lead Mine	1	.....	40	Vertical, coupled, without fly-wheel.
Do	Winnamuck group	1	.....	30	Vertical, with link motion.
Do	Yosemite	1	1	35	Horizontal, single.
SUMMIT.					
Uinta	Empire	1	1	60	Coupled, no fly-wheel.
Do	Ontario	2	2	215	Horizontal, coupled, no fly-wheel.
Do	White Pine	1	1	18	Horizontal, without fly-wheel. (b)
TOOELE.					
Ophir	Deseret	1	.....	30	
Do	Hidden Treasure	1	1	40	Vertical, with fly-wheel.
Do	Queen of the Hill	1	1	35	Vertical, coupled, without fly-wheel.
Rush Valley	First National	1	1	8	Horizontal, with fly-wheel.
Do	Great Basin	1	1	16	Horizontal, with fly-wheel.
WASATCH.					
Blue Ledge	Hawkeye	1	.....	30	Coupled.
Do	Lady of the Lake	2	2	60	Horizontal, coupled, without fly-wheel.
Snake Creek	Jenes Bonanza	1	1	45	Horizontal, coupled, without fly-wheel.
Do	Utah	1	1	40	Vertical, coupled, without fly-wheel.
WASHINGTON.					
Harrisburg, or Silver Reef	Barbee & Walker	1	1	21	Horizontal, with fly-wheel, friction gear.
Do	Christy	1	1	8	Horizontal, coupled, without fly-wheel.
Do	Kinner	1	1	10	Horizontal, with fly-wheel.
Do	Sternaut	2	2	28	One horizontal, coupled, with fly-wheel, 21 horse-power; one vertical, coupled, without fly-wheel, 7 horse-power.

VIRGINIA.

CULPEPER.					
.....	Culpeper	1	1	10	Vertical, single, direct acting, without fly-wheel.
FAUQUIER.					
.....	Kelley	1	1	25	Horizontal, geared.
LOUISA.					
Cochoe	Lane Bros	1	1	14	Horizontal, coupled, without fly-wheel.
STAFFORD.					
Hartwood township	Rappahannock	1	1	15	Horizontal, coupled, without fly-wheel.

WYOMING.

SWEETWATER.					
California	Buckeye State	1	1	20	Horizontal, with fly-wheel.
Miner's Delight	Miner's Delight	1	1	40	Horizontal, with fly-wheel.
Do	Segregated Miner's Delight	1	1	30	Horizontal, with fly-wheel.

a Estimated horse-power.
b Believed to be a coupled engine, but some single-cylinder engines, the fly-wheels of which are used as pulleys or gears, may be included.

TABLE XIX.—DEEP MINES: STEAM HOISTING ENGINES.

RECAPITULATION BY COUNTIES.

State or territory and county.	Number of mines reported.	Number of hoisting engines.	Number in use.	Horse-power.
ARIZONA.				
Maricopa	4	4	4	94
Mohave	1	1	1	12
Pima	7	8	7	135
Pinal	1	1	1	20
Yavapai	3	3	3	73
CALIFORNIA.				
Amador	9	14	13	510
Calaveras	1	2	2	80
El Dorado	3	3	3	75
Inyo	3	4	3	97
Mariposa	4	4	4	145
Mono	25	25	25	625
Nevada	7	9	8	250
Placer	1	1	1	642
Plumas	1	1	1	12
Siskiyou	1	1	1	100
Tuolumne	2	2	2	60
COLORADO.				
Boulder	12	22	12	625
Clear Creek	15	27	15	2,012
Custer	4	5	5	150
Ouray	27	51	26	1,054
Rinsdale	1	2	2	85
Lake	26	45	43	702
Ouray	1	1	.....	30
San Juan	1	1	1	5
Summit	1	2	2	81
DAKOTA.				
Lawrence	3	6	6	180
GEORGIA.				
Cobb	1	1	1	12
Forsyth	1	1	1	12
Hall	1	1	1	30
Lincoln	1	1	1	30
McDuffie	1	1	1	8
Meriwether	1	1	1	40
IDAHO.				
Alturas	1	2	2	25
Boise	2	2	2	60
Owyhee	6	6	6	135
MAINE.				
Hancock	5	5	5	115
Penobscot	1	1	1	18
Washington	1	1	1	15
York	1	1	1	35
MONTANA.				
Beaver Head	1	1	1	25
Deer Lodge	2	2	2	450
Jefferson	1	1	1	25
Lewis and Clarke	1	6	6	140
NEVADA.				
Nike	6	7	6	131
Esmeralda	2	2	2	261
Eureka	10	14	10	625
Lander	2	2	2	150
Lincoln	2	2	2	a 174
Nye	4	4	4	110
Storey	35	35	35	12,611
White Pine	4	6	6	110
NEW HAMPSHIRE.				
Coos	1	1	1	25
Grafton	1	1	1	60
NEW MEXICO.				
Grant	2	2	2	45
NORTH CAROLINA.				
Davidson	2	2	2	35
Gaston	1	1	1	20
Mecklenburg	1	1	1	15
Moore	1	1	1	15
Nash	1	1	1	15
Rowan	1	2	1	20
Stanley	1	1	1	40
OREGON.				
Baker	2	2	2	100
UTAH.				
Beaver	2	2	1	125
Juab	1	1	1	10
Salt Lake	10	11	9	215
Summit	3	4	4	205
Tooele	3	4	4	150
Wasatch	4	4	4	150
Washington	4	4	4	97
VIRGINIA.				
Culpeper	1	1	1	10
Fauquier	1	1	1	25
Loudon	1	1	1	15
Stafford	1	1	1	15
WYOMING.				
Sweetwater	2	2	2	130

a Estimated.

TABLE XX.—DEEP MINES: STEAM HOISTING ENGINES.

RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	Number of mines reported.	Number of hoisting engines.	Number in use.	Horse-power.
Total	230	433	393	32,559
Arizona	16	17	15	369
California	87	[illegible]	67	3,247
Colorado	92	[illegible]	113	3,689
Dakota	3	[illegible]	6	180
Georgia	6	6	6	113
Idaho	9	11	11	320
Maine	9	11	11	176
Montana	12	19	18	668
Nevada	85	99	90	13,723
New Hampshire	2	2	2	85
New Mexico	2	2	2	45
North Carolina	9	10	10	200
Oregon	2	2	2	100
Utah	29	34	27	1,261
Virginia	4	4	4	85
Wyoming	2	2	2	110

MACHINERY AND ITS MANIPULATION.

The practice as to the construction of hoisting engines has greatly changed in this country during the last few years. At the date of Mr. Hague's memoir on mining industries single-cylinder engines, with a heavy fly-wheel acting on the drum through toothed or friction gearing, were almost universal. The data here tabulated show that engines with two coupled cylinders are now very general, and particularly in those districts where mining has been actively prosecuted for a comparatively long period. Engines of this class are sometimes constructed with a fly-wheel and sometimes without; but when a fly-wheel is employed, it is ordinarily only sufficiently large to equalize minor irregularities of movement or to afford means of applying a brake. A considerable portion of these coupled engines are direct-acting. As has always been the case, a very great majority of the engines are horizontal, though vertical and inclined cylinders are not rare.

The statements of horse-power can only be regarded as rough approximations. As a rule, the mining superintendents do not know whether the horse-power stated is nominal or indicated. The horse-power given is for the number of engines found at the various hoisting works, and not for the number actually in use, and the table does not include idle or abandoned works, with perhaps two or three exceptions. Two main hoisting engines, driven by compressed air (compressed by steam-power), are included in the table.

The data of Table XVIII should be considered in connection with those of Table XV, showing the greatest vertical depths of the mines.

TABLE XXI.—DEEP MINES: NUMBER OF HORSE OR MULE WHIMS OR WHIPS.

State or territory.	Number of mines reported.	Number of whims or whips.
Total	61	70
Arizona	7	7
California	7	7
Colorado	17	24
Georgia	1	1
Montana	10	12
Nevada	9	9
New Mexico	1	1
North Carolina	2	2
Utah	6	6
Wyoming	1	1

This table shows the entire number of whips and whims reported in the schedules and the entire number of mines reported upon where whips and whims were employed. Most of the mines employing these means of hoisting are of sufficient size to be included in the investigation, and more than half of these machines are probably reported.

The simplest form of whip is an overhead sheave and a floor sheave to guide the traction rope. The most perfect form of whim is a somewhat elaborate engine with a friction clutch, brake, etc., and capable of working a mine, if comparatively dry, to a depth of 500 feet. Some of them are operated by two horses or mules, but one-horse whims are more common. The average price is estimated at $500.

TABLE XXII.—DEEP MINES: HOISTING CABLES.

State or territory and county.	Number of mines reported using cables, etc.	Number using steel cables: Flat.	Number using steel cables: Round.	Number using steel cables: Both flat and round.	Number using hemp or manila rope.	Number using both steel and hemp or manila rope.
ALABAMA.						
Cleburne	1				1	
ARIZONA.						
Maricopa	5		4		1	
Mohave	2		1		1	
Pima	10		7		15	2
Pinal	5		3		3	
Yavapai	3		3			
Yuma	2				2	
CALIFORNIA.						
Amador	6	2	2		2	
Calaveras	2		3		1	
El Dorado	2	1	1			
Inyo	2	1	1		1	
Lassen	2				2	
CALIFORNIA—continued.						
Mariposa	5		2		3	
Mono	26	3	23		3	
Nevada	7	(a)	6			
Placer	1		1			
Plumas	1	1				
San Diego	1				1	
Siskiyou	3	1	2			
Tuolumne	4		3		1	
COLORADO.						
Boulder	23		4		19	
Chaffee	2				2	
Clear Creek	23		4		16	3
Custer	4	1	3			
Gilpin	24	1	4		20	1
Hinsdale	1		1			

a One iron, flat, and 1 iron, round.

TABLE XXIII.—DEEP MINES: HOISTING CABLES—Continued.

State or territory and county.	Number of mines reported using cables, etc.	NUMBER USING STEEL CABLES.			Number using hemp or manila rope.	Number using both steel and hemp or manila rope.
		Flat.	Round.	Both flat and round.		
COLORADO—continued.						
Lake	26	1	26	.....	4	5
Ouray	2	.....	1	.....	1	.....
Park	1	.....	.....	.....	1	.....
San Juan	2	.....	1	.....	.....	.....
Summit	1	.....	1	.....	.....	.....
DAKOTA.						
Lawrence	2	.....	1	.....	2	.....
GEORGIA.						
Cherokee	1	.....	.....	.....	1	.....
Cobb	1	.....	1	.....	.....	.....
Forsyth	1	.....	1	.....	.....	.....
Hall	1	.....	1	.....	.....	.....
Lincoln	2	.....	.....	.....	2	.....
McDuffie	1	.....	.....	.....	1	.....
Meriwether	1	.....	1	.....	.....	.....
IDAHO.						
Alturas	4	.....	1	.....	3	.....
Boisé	5	.....	1	.....	3	1
Lemhi	1	.....	.....	.....	1	.....
Owyhee	9	.....	5	.....	4	.....
MAINE.						
Hancock	7	.....	5	.....	2	1
Penobscot	1	.....	.....	.....	1	.....
Washington	1	.....	1	.....	.....	.....
York	1	.....	1	.....	.....	.....
MONTANA.						
Beaver Head	1	.....	.....	.....	.....	1
Deer Lodge	23	(a)	9	.....	13	.....
Jefferson	1	.....	.....	.....	1	.....
Lewis and Clarke	1	.....	1	.....	.....	.....
Madison	1	.....	.....	.....	.....	1
NEVADA.						
Elko	9	1	6	.....	2	.....
Esmeralda	6	2	4	.....	.....	.....
Eureka	14	5	2	.....	7	.....
Humboldt	2	.....	.....	.....	2	.....
Lander	1	.....	.....	.....	1	.....
Lincoln	2	.....	2	1	.....	.....
NEVADA—continued.						
Nye	3	.....	4	.....	1	.....
Storey	25	19	5	6	.....	.....
White Pine	5	.....	4	.....	1	.....
NEW HAMPSHIRE.						
Coos	1	.....	.....	.....	1	.....
NEW MEXICO.						
Grant	2	.....	1	.....	1	.....
Santa Fé	1	.....	.....	.....	1	.....
NORTH CAROLINA.						
Davidson	4	.....	(b)	.....	2	1
Gaston	1	.....	1	.....	.....	.....
Guilford	1	.....	.....	.....	1	.....
Mecklenburg	2	.....	(c)	.....	1	.....
Moore	1	.....	1	.....	.....	.....
Nash	1	.....	1	.....	.....	.....
Rowan	1	.....	.....	.....	1	.....
Stanley	1	.....	1	.....	.....	.....
OREGON.						
Baker	2	.....	1	.....	.....	1
Josephine	1	.....	.....	.....	1	.....
UTAH.						
Beaver	2	1	.....	.....	1	.....
Juab	2	.....	.....	.....	2	.....
Salt Lake	6	.....	4	.....	2	.....
Summit	4	.....	1	1	1	1
Tooele	5	.....	2	.....	3	.....
Wasatch	5	(a)	1	.....	1	.....
Washington	5	.....	4	.....	1	.....
VIRGINIA.						
Buckingham	1	.....	1	.....	.....	.....
Culpeper	1	.....	1	.....	.....	.....
Fauquier	1	.....	1	.....	.....	.....
Louisa	1	.....	1	.....	1	.....
Stafford	1	.....	1	.....	.....	.....
WYOMING.						
Sweetwater	4	.....	3	.....	1	.....

a One iron, round. b One iron and rope. c One chain.

TABLE XXIII.—DEEP MINES: HOISTING CABLES.

RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	Number of mines reported using cables, etc.	NUMBER USING STEEL CABLES.			Number using hemp or manila rope.	Number using both steel and hemp or manila rope.	Various.
		Flat.	Round.	Both flat and round.			
Total	430	36	171	8	180	27	8
Alabama	1	.....	.....	.....	1	.....	.....
Arizona	41	.....	17	.....	22	2	.....
California	65	7	42	.....	14	.....	2
Colorado	118	3	35	.....	72	6	.....
Dakota	2	.....	1	.....	2	.....	.....
Georgia	8	.....	4	.....	4	.....	.....
Idaho	19	.....	7	.....	11	1	.....
Maine	10	.....	5	.....	4	1	.....
Montana	27	.....	10	.....	14	2	1
Nevada	73	27	25	7	14	.....	.....
New Hampshire	1	.....	.....	.....	1	.....	.....
New Mexico	3	.....	1	.....	2	.....	.....
North Carolina	12	.....	4	.....	6	1	1
Oregon	3	.....	1	.....	1	1	.....
Utah	27	1	13	1	11	1	1
Virginia	5	.....	4	.....	1	.....	.....
Wyoming	4	.....	3	.....	1	.....	.....

COMSTOCK HOISTING CABLES.

[A partial list, showing weight of load hoisted, average duration, and particulars as to sheaves, etc.]

AMERICAN FLAT DISTRICT.

Baltimore Consolidated.—Flat steel wire cables, 4½ inches by ¼ inch. Average load, 5,800 pounds, including weight of double-decked cage. Sheaves, 35 feet high, 7 feet in diameter. When in use, cables were taken off, cleaned, mended if necessary, and tarred once in sixty days.

GOLD HILL DISTRICT.

Alta.—Flat steel wire cables, 5 inches by ¼ inch. Average load, including cage, 5,000 pounds. Cables reported to last four years with repairs. Sheaves, 48 feet high, 7 feet in diameter.

Belcher.—Flat steel wire cables, 4 in vertical shaft, each 1,000 feet long, 3½ inches by ¼ inch; 2 in incline, each 2,000 feet long, 5 inches by ¼ inch. Average load, including cage, 5,300 pounds. Average duration, with repairs, 3 years. Sheaves, 50 feet high, 7 feet in diameter.

Belcher and Crown Point pump shaft.—In hoisting compartment, flat steel wire cable, 5 inches by ¼ inch, 5,300 feet long; in pump compartment, round steel wire cable, 1 inch in diameter, 1,000 feet long. Average load, including cage, 5 tons. Average duration, with repairs, 4 years. Height of sheaves, 30 feet; diameter, 6 feet.

Caledonia.—Two flat steel wire cables, each 1,700 feet long, 4 inches by ¼ inch; 1 round steel wire cable, ⅝ inch diameter, 350 feet long. Average load, including cage, 4,900 pounds.

Consolidated Imperial.—On surface reels, flat steel wire cables, 5 inches by ¼ inch; on winze engine reels, round steel wire cables, 1 inch in diameter. Average load in vertical shaft, 3 tons, including cage; in incline, 4½ tons, including giraffe. Average duration of cables, with repairs, 3 years. Height of sheaves, 30 feet; diameter, 8 feet.

Crown Point.—Five flat steel wire cables, 5 inches by ¼ inch; one round steel wire cable in incline, tapering from 2½ inches to 1½ inches in diameter. Average load, including cage, 5,500 pounds. Average duration, with repairs, 4 years. Height of sheaves, 18 feet; diameter, 7 feet.

Forman shaft.—Two flat steel wire cables, one English make and one American, each 3,000 feet long, 6 inches by ⅜ inch. Average load, including cage, 5 tons. Height of sheaves, 50 feet; diameter, 10 feet.

Justice.—Flat steel wire cable, 6 inches by ¼ inch. In vertical shaft average load, including cage, 1½ tons; in incline, including giraffe, 9 tons. Average duration, 2 years. Height of sheaves, 40 feet; diameter, 8 feet.

New York.—Two flat steel wire cables in vertical shaft, each 1,600 feet long. One 4 inches by ⅜ inch; one 5 inches by ⅜ inch; one incline cable 5 inches by ⅜ inch, 2,300 feet long. Average load, including cage, 2,500 pounds. Average duration, with repairs, stated at 6 years. Height of sheaves, 45 feet; diameter, 8 feet.

Overman.—Flat steel wire cables; one 5 inches by ¼ inch, 1,700 feet long; one 4½ inches by ¼ inch, 1,700 feet long; two 4 inches by ¼ inch, 350 feet long. Average load, including cage, 4,700 pounds.

Silver Hill.—Flat steel wire cables, one 5 inches by ⅜ inch, and three 4 inches by ¼ inch. Average load, including cage, 5,000 pounds. Height of sheaves, 25 and 26 feet; diameter, 5 feet and 6 feet.

Yellow Jacket.—Flat steel wire cables, each 3,700 feet long; two hoisting compartment cables 8 inches by ⅜ inch; pump compartment cable 6 inches by ¼ inch. Average load hoisted, including cage, 15,800 pounds. Large double-decked cages, with space for two cars on each floor, weighing 5,000 pounds; weight of four cars, 900 pounds each, 3,600 pounds; weight of four car loads, 1,800 pounds each, 7,200 pounds. Without mending cables lasted 3 years. Height of sheaves to centers, 55 feet; diameter, 15, 12, and 7 feet.

VIRGINIA DISTRICT.

Andes.—Flat steel wire cables, 3½ inches by ¼ inch. Average load, including cage, 3,500 pounds. Cables are spliced once in 3 months, and are said to last only 7 months. Height of sheaves, 16 feet; diameter, 5 feet.

Combination shaft (Chollar, Hale & Norcross, Potosi, and Savage).—Flat steel wire cables, 6 inches by ¼ inch. Average load, including cage, 5,500 pounds. Average duration, 14 months. Height of sheaves, 50 feet; diameter, 18 feet.

Consolidated Virginia and California joint shaft.—Flat steel wire cables; two in hoisting compartments, 7 inches by ⅜ inch; one in pump compartment, 5½ inches by ¼ inch. Average load, including cage, 12,400 pounds. Three-decker cages, weighing 4,000 pounds; three cars, 1,200 pounds each, 3,600 pounds; three car loads, 1,600 pounds each, 4,800 pounds. Average duration, 18 months. Height of sheaves, 45 feet; diameter of hoisting-compartment sheaves, 11 feet; diameter of pump-compartment sheave, 6 feet.

Gould & Curry.—Flat steel wire cables. Average load, 5,600 pounds. Height of sheaves, 30 feet; diameter, 7 feet.

Hale & Norcross.—Flat steel wire cables, 5 inches by ¼ inch. Average load in vertical shaft, including cage, 3,000 pounds; in incline, including giraffe, 5,500 pounds. Height of sheaves, 36 feet; diameter, 8 feet. Incline cable lasts only 6 months.

Mist.—Round steel wire cables, one 1-inch diameter, and one ⅞-inch diameter, each 1,500 feet long. Average load, 1,800 pounds. Average duration without mending, 3 years. Height of sheaves, 27 feet; diameter, 2 feet.

Ophir.—Two flat steel wire cables, 5 inches by ¼ inch, in vertical shaft; round steel wire cable in incline, tapering from 2½ inches to 2 inches. Average load, including cage, 8,600 pounds. Weight of double-decked cage, 3,000 pounds; two cars, 1,200 pounds each, 2,400 pounds; two car loads, 1,600 pounds each, 3,200 pounds. Average duration with repairs, 2 years. Height of sheaves, 30 feet; diameter, 7 feet.

Original Keystone.—Flat steel wire cables, 4 inches by ¼ inch. Average load, including cage, 4,000 pounds. Average duration, with repairs, 2 years. Height of sheaves, 40 feet; diameter, 6 feet.

Ophirton shaft (Best & Belcher and Gould & Curry joint shaft).—Two flat steel wire cables, each 2,500 feet long, 5 inches by ¼ inch. Average load, including cage, 7,000 pounds. Average duration with repairs, 4 years. Height of sheaves, 30 feet; diameter, 6 feet.

Savage.—Two flat steel wire cables in vertical shaft, each 1,500 feet long, 5½ inches by ⅜ inch. Round steel wire incline cable, 4,000 feet long, 2½ inches diameter. Average load in vertical shaft, including cage, 3,600 pounds; in incline, including giraffe, 5,000 pounds. Average duration with repairs, 3 years. Height of sheaves, 40 feet; diameter, 6, 8, and 15 feet.

Scorpion.—Round steel wire cables, 1 inch in diameter. Average load, cage, car, and rock, 2,500 pounds; bailing tank and water, 5,000 pounds. Average duration with repairs, 2 years. Height of sheaves, 20 feet; diameter, 5 feet.

Sierra Nevada.—Flat steel wire cables, 5 inches by ¼ inch. Average load, 4,500 pounds, including cage weighing 1,500 pounds; car, 1,200 pounds, and rock, 1,800 pounds. Average duration, 4 years. Height of sheaves to centers, 25 feet; diameter, 8 feet.

Union shaft (Maricopa, Sierra Nevada, and Union Consolidated joint shaft).—Flat steel wire cables; two in hoisting compartments, 7 inches by ¾ inch; one in pump compartment, 5¼ inches by ¾ inch. Average load hoisted, 13,500 pounds, including three-decker cage, 4,500 pounds; three cars, 1,200 pounds each, 3,600 pounds; three car-loads, 1,800 pounds each, 5,400 pounds. When bailing, hoist 1,000-gallon iron tank weighing, shell and water, 9,812 pounds. Average duration with repairs, 4 years. Splices are from 75 to 100 feet long. "Cables wear most rapidly at points over sheaves corresponding to distances of stations; the wear is also more rapid when there is an over and under bend on rope and sheave." Height of sheaves to center, 45 feet; diameter, 12 feet.

Utah.—Flat steel wire cables; vertical-shaft cables, 4 inches by ¾ inch; incline, 6 inches by ¾ inch. Average load in vertical shaft, including cage, 3,500 pounds; in incline, including giraffe, 9,000 pounds. Average duration with repairs: vertical shaft, 5 years; in incline, about 2 years. Height of sheaves, 25 feet; diameter, 6 and 8 feet.

Ward shaft (Bullion Combination).—Flat steel wire cable, 6 inches by ¾ inch. Average load, including cage, 6,000 pounds. Average duration with repairs, only 18 months when in constant use. Height of sheaves, 50 feet; diameter, 10 feet; face, 7 inches.

The round steel cable reported in Siskiyou county, California, is used for a tramway at the Klamath mine.

The incline cables on the Comstock are round steel. The Crown Point mine, Gold Hill, Storey county, Nevada, uses two tapered round steel cables in addition to five of flat steel. The tapered cables are 2¼ inches at top and 1¼ inches at bottom. The Ophir mine, Virginia district, Storey county, Nevada, uses a tapered round steel cable in the incline 2¼ inches at top and 2 inches at bottom. These two mines are the only ones reporting tapered cables. While so far as the distribution of the load is concerned tapered cables present a decided advantage, they are much less readily repaired, and cannot be reversed. They were much more frequent a few years ago than they now are.

Hemp or manila ropes are used only in comparatively shallow workings and where moderate quantities of ore are raised. The largest reported in the state of Nevada was 3 inches in diameter, and raised an average load of 2,200 pounds, including weight of cage; the smallest was 1¼ inches in diameter, and raised but 250 pounds. Hemp and manila cables last from three to eighteen months, and average from ten to twelve months.

A dozen years since steel cables were being introduced but slowly. Though their advantages were evident, it was found that they were apt to give out unexpectedly, and without warning. The difficulties of manufacturing a steel wire suitable for the purpose have now been overcome, and there are but few iron cables left. For large cables the flat form is commonly preferred to the round. A heavy round cable must be wound on an enormous drum to escape injury by bending, while the flat rope can be wound on a reel of small width and of no larger diameter than would be suitable for one of the small ropes of which it is composed. The flat rope can also be more readily inspected and repaired. These advantages more than counterbalance the slight additional weight of metal necessary to obtain the same strength as the round cable would possess. The smallest steel cable reported is ⅜ of an inch in diameter, and carries a load of 330 pounds; the largest are those running in the deepest shaft, the "New Yellow Jacket" of Washoe. It is a flat rope ⅝ of an inch thick and 8 inches broad, and carries a load of 15,800 pounds. The average load for steel wire ropes in the state of Nevada, excepting Washoe district, is a ton and a quarter, but on the Comstock it is about three tons. Steel cables last from four months to six years, with an average of two years.

Iron cables are used by the following mines:

New York Hill, Grass valley, Nevada county, California (flat).

Nevada City mine, Nevada City, Nevada county, California (round).

Penobscot & Snowdrift mine, Silver Creek district, Deer Lodge, Montana (round).

Conrad Hill, Davidson county, North Carolina, uses round iron and rope.

Utah mine, Snake Creek district, Wasatch county, Utah (round).

The McGinn mine, Capp's Hill district, Mecklenburg county, North Carolina, is the only one reported using a chain. This was reported in good condition after five years' wear; its load, however, was only 200 pounds.

Mines using hemp or manila rope		180
Mines reported using flat steel cables	38	
Mines reported using round steel cables	171	
Mines reported using both flat and round steel cables	8	
Mines reported using both steel and rope	17	
	—	234
Mines using flat iron cables	1	
Mines using round iron cables	4	
	—	5
Mines reported using chain		1
Total		420

The list includes a few windlass cables and several horse whims, but the great majority are those of steam hoisting works. As the best horse whims are capable of hoisting from a depth of 500 feet, the requirements for a cable correspond with those for steam hoisting works using buckets.

DEEP MINES: INSPECTION OF HOISTING CABLES.

ALABAMA.—One report; weekly inspection.

ARIZONA.—Forty-one reports. Eleven mines report inspection; one no inspection. Daily inspection, 8; weekly, 3. No returns from 29 mines using cables.

CALIFORNIA.—Sixty-five reports. Forty-two mines report inspection; two no inspection. Daily, 33; semi-weekly, 4; weekly, 3; irregularly, 2; weekly when cable is new, daily when old, 1. No returns from 21 mines using cables.

COLORADO.—One hundred and eighteen reports. One hundred mines report inspection; two no inspection. Constantly, 7; twice a day, 1; daily, 78; tri-weekly, 1; weekly, 5; irregularly, 8. No returns from 16 mines using cables.

DAKOTA.—Three reports. Each mine reports daily inspection.

GEORGIA.—Eight reports. Four mines report inspection; two no inspection. Irregularly, 3; semi-annually, 1. No returns from 3 mines using cables.

IDAHO.—Nineteen reports. One mine reports constant inspection; three no inspection. No returns from 15 mines using windlass ropes.

MAINE.—Ten reports. Nine mines report inspection. Constantly, 1; twice a day, 1; daily, 7. No returns from 1 mine.

MONTANA.—Twenty-seven reports. Twenty-two mines report daily inspection. No returns from 5 mines.

NEVADA.—Seventy-three reports. Forty-three mines report inspection. Constantly, 7; daily, 31; "every day or two," 1; weekly, 3; occasionally, 1. No returns from 30 mines.

NEW HAMPSHIRE.—One report; inspection not stated.

NEW MEXICO.—Three reports. Two mines report daily inspection. From one mine no statement as to inspection.

NORTH CAROLINA.—Twelve reports. Each mine reports inspection. Daily, 10; weekly, 1; every two months, 1.

OREGON.—Three reports. Two mines report daily inspection, and one mine no inspection.

UTAH.—Twenty-seven reports. Nine mines report inspection; seven no inspection. Daily, 1; irregularly, 7; "seldom," 1. No returns from 11 mines using cables.

VIRGINIA.—Five reports. Daily inspection, 3; weekly, 2.

WYOMING.—Four reports. Constant inspection, 2; daily, 2.

RECAPITULATION.

	Number of mines.
Inspected constantly	18
Inspected twice a day	2
Inspected daily	201
Inspected tri-weekly	1
Inspected "every day or two"	1
Inspected semi-weekly	4
Inspected weekly	18
Inspected weekly when cable is new, daily when old	1
Inspected irregularly, occasionally, or seldom	22
Inspected every two months	1
Inspected semi-annually	1
Total number of mines reporting inspection of any kind	270
Mines reporting no inspection	18
Mines using cables, etc., from which there are no returns	122
Total number reports	410

It is evidently the prevailing practice, at least in theory, to inspect cables daily, though it is not impossible that some mines have exaggerated the vigilance exercised. In large mines a special rope man is generally employed, whose duty it is to keep constant watch of the cables in use, except when actually engaged in repairing spare cables. The instances in which cables are not properly inspected are comparatively few. The miners are sufficiently awake to their own interest in most cases to see that this duty is thoroughly performed, and no mine can afford to acquire the reputation of neglecting the hoisting apparatus. It might at first sight appear to be safer to throw out cables which showed signs of wear and put in fresh ones, and this method is actually practiced to some extent with fiber ropes and small steel cables. With heavy cables, however, such a course would be ruinously expensive, and there would be a strong tendency to delay renewal too long. Flat cables in particular can be easily and thoroughly repaired by splicing in new strands or sections. Cables wear most at certain points, especially where they rest upon the sheave when the cage stands at a station.

TABLE XXIV.—DEEP MINES: MODE OF HOISTING.

State or territory and county.	Number of mines where mode of hoisting is specified.	Number hoisting with cages.	Number hoisting with buckets or kibbles only.	Number hoisting with skips or glunks.	Number hoisting by other means.
ALABAMA.					
Cleburne	1		1		
ARIZONA.					
Maricopa	4		4		
Mohave	1		1		
Pima	25	1	24		
Pinal	5	1	4		
Yavapai	3	1	2		
Yuma	3		3		
CALIFORNIA.					
Amador	6		1	5	
Calaveras	3		3		
El Dorado	2	1	1		
Inyo	3	1	1	1	
Lassen	3		3		
Mariposa	5		5		
Mono	24	13	11	1	
Nevada	7		1	5	1
Placer	1		1		
Plumas	1			1	
San Diego	1		1		
Siskiyou	1				1
Tuolumne	2		1	1	
COLORADO.					
Boulder	20	1	17	2	
Chaffee	3		2		1
Clear Creek	23	1	18	3	1
Custer	4	1	2		1
Gilpin	34	1	33		
Hinsdale	1		1		
Lake	26	3	21	2	
Ouray	3	1	1		
Park	1		1		
San Juan	3		3		
Summit	1				1
DAKOTA.					
Lawrence	3	1	2		
GEORGIA.					
Cherokee	1		1		
Cobb	1		1		
Forsyth	1		1		
Hall	1		1		
Lincoln	1		1		
McDuffie	1		1		
Meriwether	1	1			
IDAHO.					
Alturas	4	1	3		
Boisé	5	1	4		
Lemhi	2		2		
Owyhee	3		3		
MAINE.					
Hancock	7	1	6		
Penobscot	1		1		
Washington	1			1	
York	1			1	
MONTANA.					
Beaver Head	1				1
Deer Lodge	23	4	16	1	2
Jefferson	1		1		
Lewis and Clarke	1	1			
Madison	1		1		
NEVADA.					
Elko	9	4	5		
Esmeralda	6	5	1		
Eureka	11	6	5		
Humboldt	2		2		
Lander	3	1	1		1
Lincoln	2		2		
Nye	3	2			1
Storey	26	26			
White Pine	3	1	2		
NEW HAMPSHIRE.					
Coos	1		1		
Grafton	1		1		
NEW MEXICO.					
Grant	2		2		
Santa Fé	1		1		
NORTH CAROLINA.					
Davidson	4		3		1
Gaston	1	1			
Guilford	1		1		
Mecklenburg	2		2		
Moore	1		1		
Nash	1		1		
Rowan	1		1		
Stanley	1		1		
OREGON.					
Baker	1		1		
Josephine	1		1		
UTAH.					
Beaver	2	1	1		
Juab	3		3		
Salt Lake	2		2		
Summit	4	3	1		
Tooele	5		1	1	3
Wasatch	3		2		1
Washington	5	1	3		1
VIRGINIA.					
Buckingham	1	1			
Culpeper	1		1		
Fauquier	1		1		
Louisa	1		1		
Stafford	1		1		
WYOMING.					
Sweetwater	4		4		

TABLE XXV.—DEEP MINES: MODE OF HOISTING.

RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	Number of mines whose mode of hoisting is specified.	Number hoisting with cages.	Number hoisting with buckets or Ehniles only.	Number hoisting with skips or giraffes.	Number hoisting by other means.
Total	320	67	271	24	17
Alabama	1	.....	1	.....	.....
Arizona	40	3	37	.....	.....
California	58	14	28	14	2
Colorado	116	8	96	6	4
Dakota	3	1	2	.....	.....
Georgia	8	1	7	.....	.....
Idaho	19	2	17	.....	.....
Maine	10	1	7	2	.....
Montana	27	3	18	1	3
Nevada	65	45	18	.....	2
New Hampshire	2	.....	2	.....	.....
New Mexico	3	.....	3	.....	.....
North Carolina	12	1	10	.....	1
Oregon	2	.....	2	.....	.....
Utah	24	3	13	1	5
Virginia	5	1	4	.....	.....
Wyoming	4	.....	4	.....	.....

Where cages are used, the shafts are generally two or more compartments in width, so that the table does not give the number of cages, but of mines using cages. In almost all mines of any size windlass buckets are used in winzes. These are not included in the table.

The column headed "Number hoisting with skips or giraffes" includes only those mines using either skips or giraffes as a principal means of hoisting. Of the 24 cases tabulated, 22 use skips alone and 2 use giraffes alone. Besides these, 5 of the mines reported as using cages as a principal means of hoisting use also skips, and 10 of the cage mines use giraffes. So that altogether skips are used in 27 mines and giraffes in 12 mines.

The column headed "Number hoisting by other means" includes 16 mines in which cars are hoisted by windlass, whim, or steam machinery on inclined tracks, and one case, in North Carolina, where wooden boxes, made for the purpose, are used. The cars used on the inclines are either ordinary mine cars standing on a platform, or, when the incline is very steep, the front wheels are of smaller diameter than the hind wheels.

Rawhide buckets are used on account of lightness, flexibility, and freedom from breaking by knocking against timbers, etc.

Safeties against falling are employed in about nine out of ten cases where cages are used in hoisting. The favorite form of safety clutch consists of two pairs of eccentrics provided with teeth and pressed against the guide by springs when the rope is detached, but many other patterns are in use. Safeties against overwinding are constructed on two different principles. In one the attachment between the rope and the cage is effected by a clutch, which is opened when it enters a ring or cone set in the gallows-frame above the shaft. The cage is thus set free, and depends upon the safeties against falling. By the other plan, when the cage reaches a certain level above the top of the shaft it controls a valve, which shuts steam off from the engine, and thus prevents further hoisting. This latter method is evidently the safer of the two, because where the first is employed, if the safeties against falling are out of order, the gravity of the accident is likely to be increased rather than to be diminished by the means used to avoid it. Safeties against overwinding are looked upon with disfavor by some superintendents, who fear anything tending to diminish the responsibility of the engine driver. The objection, however, scarcely seems valid. The great loss of life which has resulted from overwinding indicates the propriety of introducing preventives much more widely than has as yet been done in this country. A great disadvantage of inclines, as compared with vertical shafts, is that the introduction of efficient safeties against falling in inclines is difficult or perhaps impossible.

Safeties sometimes fail to act when needed either because the clutches do not move or because the guides give way, but in a vast majority of cases where the construction is good and the apparatus properly inspected they obviate or greatly mitigate catastrophes.

Mines having:

Cages with safeties against falling and against overwinding	5
Cages with safeties against falling, but not against overwinding	79
Cages provided with no safeties whatever	8
Cages with no safeties specified	2
	87

Mines having:

Buckets with safeties against falling, but not against overwinding	2
Buckets with safeties against overwinding, but not against falling	1
Buckets provided with no safeties whatever	268
	271

TABLE XXVI.—DEEP MINES: MODE OF SIGNALING.

State or territory and county.	Number of mines whose mode of signaling is specified.	Wire or rope and gong or bell.	Vocal.	Various.
ARIZONA.				
Maricopa	5	5		
Mohave	2	2		
Pima	18	2	16	
Pinal	5	3	2	
Yavapai	3	3		
Yuma	2	2		
CALIFORNIA.				
Amador	6	6		
Calaveras	2	2		
El Dorado	2	2		
Inyo	2	2		
Lassen	2	2		
Mariposa	5	4	1	
Mono	28	28		
Nevada	7	7		
Placer	1	1		
Plumas	2	1	1	
San Diego	1	1		
Siskiyou	1	1		
Tuolumne	3	3		
COLORADO.				
Boulder	18	15	2	1
Chaffee	2		2	
Clear Creek	22	18	2	2
Custer	4	4		
Gilpin	34	22	2	10
Hinsdale	1	1		
Lake	25	24		1
Ouray	2	2		
Park	1			1
San Juan	4	1	2	1
Summit	1	1		
DAKOTA.				
Lawrence	3	3		
GEORGIA.				
Cherokee	1		1	
Cobb	1	1		
Forsyth	1		1	
Hall	1		1	
Lincoln	2	1	1	
McDuffie	1	1		
Meriwether	1	1		
IDAHO.				
Alturas	13	1	12	
Boisé	7	2	5	
Lemhi	4		4	
Owyhee	9	6	3	
MAINE.				
Hancock	7	6	1	
Penobscot	1	1		
Washington	1	1		
York	1	1		

State or territory and county.	Number of mines whose mode of signaling is specified.	Wire or rope and gong or bell.	Vocal.	Various.
MONTANA.				
Beaver Head	1	1		
Deer Lodge	23	21		1
Jefferson	1			1
Lewis and Clarke	1	1		
NEVADA.				
Elko	10	6	4	
Esmeralda	6	6		
Eureka	14	14		
Humboldt	3		3	
Lander	1	1		
Lincoln	3	3		
Nye	3	3		
Storey	28	28		
White Pine	4	4		
NEW HAMPSHIRE.				
Coos	1	1		
NEW MEXICO.				
Grant	2	1		1
Santa Fé	1		1	
NORTH CAROLINA.				
Davidson	4	2	2	
Gaston	1	1		
Guilford	1		1	
Mecklenburg	2	2		
Moore	1	1		
Nash	1	1		
Rowan	1	1		
Stanley	1		1	
OREGON.				
Baker	2	2		
Josephine	1		1	
UTAH.				
Beaver	2	1	1	
Juab	2	2		
Salt Lake	5	5		
Summit	4	4		
Tooele	4	4		
Wasatch	3	3		
Washington	5	4		1
VIRGINIA.				
Buckingham	1	1		
Culpeper	1	1		
Fauquier	1	1		
Louisa	1	1		
Stafford	1	1		
WYOMING.				
Sweetwater	5	5		

TABLE XXVII.—DEEP MINES: MODE OF SIGNALING.

RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	Number of mines, whose mode of signaling is specified.	Wire or rope and gong or bell.	Vocal.	Various.
Total	422	331	73	20
Arizona	42	24	18	
California	61	50	2	
Colorado	114	86	10	18
Dakota	3	3		
Georgia	8	4	4	
Idaho	33	9	24	
Maine	10	9	1	
Montana	25	20		2
Nevada	73	67	6	
New Hampshire	1	1		
New Mexico	3	1	1	1
North Carolina	13	8	4	
Oregon	3	2	1	
Utah	23	22	1	1
Virginia	5	5		
Wyoming	5	5		

The column headed "various" contains the following:

Number of mines using the telephone	3
Number of mines using the telegraph	1
Number of mines using Cornish clappers	9
Number of mines using triangles	4
Number of mines using knockers	3
	20

SIGNALS USED IN ADDITION TO WIRE OR ROPE AND GONG OR BELL.

Several of the mines using wire or rope and gong or bell as a principal means of signaling have also other signals. Among these are:

Telephone	1
Telegraph	2
Speaking-tube	3
Cornish clappers	2
Triangle	1
Shaking rope	2
Rapping on bucket	1
	12

Of the important mines only 72 use vocal signals alone, but in the large number of workings not scheduled signals by voice are generally the only means of communication. The telephone or the telegraph would seem to be the most desirable means of signaling in large mines were it practicable to preserve the insulation of the wires. In most cases where it has been tried, however, difficulties have been experienced from imperfections of insulation. The wires must pass down the shaft, and are subject to mechanical abrasion. Most shafts, too, are wet, and in a very great proportion the water contains more or less sulphuric acid. The batteries, also, introduce a complication which, though not fatal, is undesirable. These disadvantages, however, may be overcome, and experiments are being made on telegraphic methods which, when in good order, permit signals to be sent to the surface from the cage even when this is moving at a maximum velocity. Considerable money and much care would be well expended on such a device if these would suffice to maintain it in a reliable condition.

The commonest means of signaling in mines of considerable size is by a bell-rope, and this method has the advantage of extreme simplicity. In deep shafts, however, it requires much force to ring such a bell, and when the cage is in rapid motion it is extremely difficult to communicate with the surface. A very large proportion of accidents are induced or aggravated by the difficulties of signaling and the imperfections of signaling apparatus.

TABLE XXVIII.—DEEP MINES: MEANS OF HANDLING WATER.

ALABAMA.

County and district.	Mine.	Means of handling water.	Capacity in gallons per hour.
CLEBURNE.			
.....	Houston & Pinson	Hand-pump	1,800

ARIZONA.

MOHAVE.			
Hualapai	Keystone	Cameron No. 5	
Do	Lone Star	Bail with barrel	
PIMA.			
Arivaca	Consolidated Arizona	Steam force-pump	
Pima	Esperanza	Bail with bucket	
YAVAPAI.			
Humbug	Tip-Top	Bail with tank	
Pook	Pook	Blake steam force-pump	
Tiger	Tiger	Cornish pumping engine	4,500

CALIFORNIA.

AMADOR.			
Amador City	Keystone Consolidated	Cornish pumping engine at south shaft	14,000
Do	Original Amador	Steam force-pump	
Jackson	Oneida	Bail with bucket	
Do	Zelle	do	
Plymouth	Empire	Bail with skip	
Sutter Creek	Consolidated Amador	Cornish pumping rig driven by hurdy-gurdy wheel	8,000
CALAVERAS.			
Independence	Champion	Cornish pumping rig driven by overshot wheel, water also hoisted in buckets.	
Mokelumne Hill	Gwin	Cornish pumping rig driven by water-power	
Washington	Amelia	Bail with tank; hoisted by independent engine	
EL DORADO.			
Springfield, or Mud Springs	Springfield	Cornish pumping rig and Hooker force-pump; capacity 10,000 gallons per hour each; also bail with tank.	20,000
MARIPOSA.			
Hornitos	Washington	Cornish pumping engine	12,000
Mariposa Estate	Mariposa tunnel and Sacredo	Two Hooker steam force-pumps	
MONO.			
Bodie	Bodie Consolidated	Two Cope & Maxwell steam force-pumps	12,000
Do	Booker Consolidated	Cornish pumping engine	
Do	Champion	Compound Cornish pumping engine	22,500
Do	Dudley	Two Cope & Maxwell steam force-pumps	17,928
Do	Goodshaw	Cope & Maxwell steam force-pump	10,000
Do	Jupiter	do	15,000
Do	Noonday	Three Cope & Maxwell direct-acting steam force-pumps	
Do	South Bodie	Two Hooker steam force-pumps	
Do	South Belwer	Two Cope & Maxwell steam force-pumps	
Do	Standard Consolidated	Cornish pumping engine	
NEVADA.			
Grass Valley	Idaho	Cornish pumping engine	10,000
Do	New York Hill	do	
Do	Rocky Bar	Cornish pumping rig	
Nevada City	Murchie	Cornish pumping engine	10,000
Do	Nevada City	do	10,000
Do	Providence	do	
PLACER.			
Colfax	Rising Sun	Cornish pumping rig, connected with hoisting engine	20,000
SISKIYOU.			
South Fork Salmon	Black Bear	Two Blake steam force-pumps	1,200
TUOLUMNE.			
Confidence	Confidence	Cornish pumping rig, connected with hoisting engine	7,000
Soulsbyville	Soulsby	do	14,000

COLORADO.

BOULDER.			
Grand Island	Boulder County and Trojan	One Blake No. 7, one Knowles No. 5, one Knowles No. 2	1,100
Do	Caribou	Three Knowles steam force-pumps	
Do	Native Silver	Deane steam force-pump	1,000
Magnolia	Keystone	Knowles steam force-pump	75
CLEAR CREEK.			
Downieville	Red Elephant	Two Blake and one Knowles steam force-pumps	
Griffith	Colorado Central Consolidated	National steam force-pump	4,000
Griffith and Queens	Colorado Territory National	Blake No. 5 steam force-pump	
Idaho	Champion	Bail with bucket	
Upper Union	Fred. Rogers	Knowles No. 3 steam force-pump	600

TABLE XXVIII.—DEEP MINES: MEANS OF HANDLING WATER.

COLORADO—Continued.

County and district.	Mine.	Means of handling water.	Capacity in gallons per hour.
CLEAR CREEK—continued.			
Upper Union	Pioneer	Cornish pumping rig, driven by mill engine	3,000
York	Clifford	Bail with bucket	
CUSTER.			
Verde	Verde	Rider hot-air pump	400
GILPIN.			
Eureka	Gunnell	Cornish pumping engine	9,000
Gregory	Bobtail	Two Worthington and one Knowles steam force-pumps	30,000
Do	New York and Colorado	Cornish pumping engine	4,000
Do	United Gregory	do	87,220
Do	Wain	Bail with bucket	
Hawkeye	Hard Money	Knowles steam force-pump	900
Nevada	California	Bail with bucket	
Do	Kansas	Cornish pumping engine	9,000
Do	Kansas lode	Bail with iron bucket	
Quartz Valley	Boss	Bail with buckets	
Russell	Haseltine	Cornish pumping engine	11,000
Do	Pewabic	One Knowles, one Cameron steam force-pumps	24,000
Do	Wyandotte	Bail with bucket	
LAKE.			
California	Amie	Knowles No. 8 steam force-pump	30,000
Do	Chrysolite	Knowles 4-inch steam force-pump	200
Do	Iron	Knowles No. 2 steam force-pump	
Do	Little Chief	Knowles 4-inch steam force-pump	
Do	Little Pittsburgh	Knowles No. 6 steam force-pump	
Do	Miner Boy	Cornish pumping engine	
Do	Robert E. Lee	Bail with tank	
SUMMIT.			
Consolidated Ten-mile	Robinson Consolidated	One Keystone, 10 horse-power; one Knowles, 6 horse-power	5,000

DAKOTA.

LAWRENCE.			
Bear Butte	Escondido	One Knowles, 10,500 gallons; one Smith & Briggs, 6,000 gallons	16,500
Whitewood	Homestake	One Knowles No. 3, one Knowles No. 5, one Knowles No. 8; also use a 500-gallon iron bailing tank.	
Do	Sir Roderick Dhu	Knowles steam force-pump	1,750

GEORGIA.

CHEROKEE.			
Third and Second	Parks	Two steam force-pumps	6,000
COBB.			
	Kendrick	Deane steam force-pump	12,000
FORSYTH.			
Third and Second	Strickland	Deane No. 6 horse-power steam force-pump	12,000
HALL.			
Ninth	Harris	Blake No. 2 steam force-pump	2,200
LINCOLN.			
	Magruder	Cornish pumping rig driven by hoisting engine	
	Sale	Two "ejectors" driven by mill engine	2,000
M'DUFFIE.			
Republican	Jennings	Two Worthington steam force-pumps	
MERIWETHER.			
Latherville	Wilkes	Cornish pumping rig driven by hoisting engine	

IDAHO.

ALTURAS.			
Middle Boise	Buffalo	Bail with tank	
BOISÉ.			
Banner	Crown Point and Wolverine	Knowles No. 4½ steam force-pump; also two-man hand-pump	2,004
Granite	Gold Hill	Stevens & Conduct, Hooker, and Knowles steam force-pumps, at 100 feet, 250 feet, and 400 feet stations, respectively.	75,000
OWYHEE.			
Carson	Clearbrook Consolidated	Bail with bucket	
Do	Empire	do	
Do	Owyhee	do	
Do	Potosi	do	
Wagontown	Tremont Consolidated	Hooker No. 2 steam force-pump	700

TABLE XXVIII.—DEEP MINES: MEANS OF HANDLING WATER.

MAINE.

County and district.	Mine.	Means of handling water.	Capacity in gallons per hour.
HANCOCK.			
Goldsboro'	Goldsboro'	Knowles steam force-pump	9,000
Sullivan	Ashley	Knowles No. 3 steam force-pump	
Do	Milton	Knowles No. 4 steam force-pump	
Do	Waukeag	Knowles steam force-pump	
West Sullivan	Sullivan	One Knowles No. 5 and one Knowles No. 6 steam force-pumps	
	Deer Isle	Knowles No. 3 steam force-pump	1,500
PENOBSCOT.			
	Consolidated Hampden	Blake No. 4 steam force-pump	5,000
WASHINGTON.			
Fifth	Cherryfield	Knowles No. 3 steam force-pump	2,250
YORK.			
Acton	Acton Consolidated	Cornish pumping engine	

MONTANA.

DEER LODGE.			
Flint Creek	Algonquin	Two Knowles steam force-pumps	12,000
Do	Speckled Trout	One vertical Knowles; one horizontal Knowles	1,200
Independence	Mountain Boy	One Knowles, vertical No. 7	10,000
Silver Creek	Penobscot and Snowdrift	One Worthington and one Knowles	12,000
Summit Valley	Alice	Knowles steam force-pump, 330 horse-power	72,000
Do	Colusa	Knowles No. 6 steam force-pump	
Do	Gagnon	Four Knowles steam force-pumps	15,000
Do	Morning Star	Knowles vertical No. 4	2,000
Do	Star West	Knowles steam force-pump	
LEWIS AND CLARKE.			
Owyhee	Union No. 2	Cornish pumping engine and 6 steam force-pumps	2,000
MADISON.			
Hot Spring	Red Bluff	Bail with bucket	

NEVADA.

ELKO.			
Tuscarora	Argenta	Bail with barrel	
Do	Grand Prize	Cornish pumping engine and two Blake steam force-pumps	21,450
Do	Independence	Bail with barrel	
Do	Navajo	One Knowles and one Hamilton steam force-pump	
Do	North Belle Isle	Bail with barrel	
Do	Silver Star	do	
Do	Tuscarora	Bail with bucket	
ESMERALDA.			
Esmeralda	Real del Monte	Cornish pumping engine, 200 horse-power	38,500
Wilson	Wilson	Cornish pumping engine	
EUREKA.			
Eureka	Eureka Consolidated	Two Hooker and one Garratt steam force-pumps	6,000
LANDER.			
Reese River	Curtis	Five compressed-air donkey pumps	1,000
LINCOLN.			
Ely	Raymond & Ely	Cornish pumping engine	
NYE.			
Philadelphia	Belmont	Cornish pumping engine, 60 horse-power	
Tybo	Tybo Consolidated	One Cameron and one Blake steam force-pump	10,000
Union	Great American Rooster	Two steam force-pumps	
STOREY.			
American Flat	Baltimore Consolidated	Cornish pumping engine	
Gold Hill	Alta	do	
Do	Belcher and Crown Point pump shaft	do	30,000
Do	Caledonia	do	25,200
Do	Consolidated Imperial	do	14,100
Do	Forman shaft	do	6,500
Do	Justice	do	11,292
Do	Overman	do	
Do	Silver Hill	One Cameron No. 4; one Blake No. 6	9,900
Do	Yellow Jacket	Cornish pumping engine	18,000
		Cornish pumping engine and four Cope & Maxwell No. 5 force-pumps; also bail with tank.	67,200
Virginia	C. & C. shaft	Cornish pumping engine; also bail with tank	
Do	C. N. S. shaft	Cornish and hydraulic pumping engines; also bail with tank	32,400
Do	Gould & Curry	Knowles steam force-pump	98,000
Do	Hale & Norcross	Cornish pumping engine	1,200
Do	Mint	Bail with tank	10,740

TABLE XXVIII.—DEEP MINES: MEANS OF HANDLING WATER.

NEVADA—Continued.

County and district.	Mine.	Means of handling water.	Capacity in gallons per hour.
STOREY—continued.			
Virginia	Ophir	Cornish pumping engine	21,000
Do	Original Keystone	Steam force-pump; also bail with tank	5,000
Do	Ophir and Gould & Curry	Cornish pumping engine	24,000
Do	Savage	do	30,000
Do	Sierra Nevada	do	22,000
Do	Union shaft	Cornish pumping engine and 8 steam-force pumps; also bail with tank	41,500
Do	Utah	Cornish pumping engine	12,500
WHITE PINE.			
Cherry Creek	Star	Two Wilcox steam force-pumps	5,040
NEW MEXICO.			
GRANT.			
Silver Flat	Massachusetts and New Mexico	Daws No. 3 steam force-pump	1,500
NORTH CAROLINA.			
DAVIDSON.			
Emmons township	Silver Valley	Cornish pumping engine and two Knowles steam force-pumps	83,760(?)
	Conrad Hill	Two Knowles steam force-pumps	18,000
	Ethan Allen	Cornish pumping engine	
GASTON.			
	King's Mountain	Cornish pumping engine	17,846
GUILFORD.			
	Fisher and Willis Hill	Deane steam force-pump	8,000
MECKLENBURG.			
Capp's Hill	McGinn	Cornish pumping rig, driven by hoisting engine	9,300
Sixth	Rudisill	Cornish pumping engine	14,400
MOORE.			
	Henly Hill	Cameron steam force-pump	2,400
NASH.			
Griffith township	Mann	Knowles No. 7 steam force-pump	
ROWAN.			
	Dunn's Mountain	Two Knowles steam force-pumps	10,000
OREGON.			
BAKER.			
Rye Valley	Rye Valley	Steam force-pump	8,000
	Virtue	Two Blake and one Cameron steam force-pump	45,000
UTAH.			
BEAVER.			
San Francisco	Carbonate	Bail with bucket	
JUAB.			
Tintic	Elmer Ray	do	
SALT LAKE.			
Little Cottonwood	Emma	One Knowles No. 6, one Knowles No. 7, run by compressed air	No. 6, 6,000
Do	Flagstaff	Knowles No. 4, run by compressed air	
Do	Toledo	One Knowles No. 3 and one Knowles No. 6, run by compressed air	
West Mountain	Last Chance	Knowles No. 7	
Do	Queen & Bemis	Deane No. 9 steam force-pump	
Do	Winnamuck Group	One Blake and one Knowles	
Do	Yosemite	Blake No. 3 and Blake No. 7	
SUMMIT.			
Uintah	Empire	Two Blake and two Worthington steam force-pumps; also 400-gallon bailing tank	83,500
Do	Ontario	Fourteen steam force-pumps; also 700-gallon bailing tank	102,000
Do	White Pine	Two Knowles No. 6½	
UTAH.			
Silver Lake	Milkmaid	Hand force-pump	375
WASATCH.			
Blue Ledge	Hawkeye	Three steam force-pumps	
Do	Lady of the Lake	One Blake and one Knowles	
Snake Creek	Jones Bonanza	One Blake No. 4 and one Knowles No. 6½	12,000
Do	Utah	One Niagara No. 3 and one Ferry No. 5	15,000

TABLE XXVIII.—DEEP MINES: MEANS OF HANDLING WATER.

UTAH—Continued.

County and district.	Mine.	Means of handling water.	Capacity in gallons per hour.
WASHINGTON.			
Harrisburg, or Silver Reef	Christy	Two Blake No. 5	
Do	Kinner	Crane No. 3 steam force-pump	1,458

VIRGINIA.

BUCKINGHAM.			
Curdsville	Morrow	Cornish pumping engine	7,200
FAUQUIER.			
	Kelley	do	8,000
LOUISA.			
Cochoo	Luce Bros	Cornish pumping rig, driven by hoisting engine	8,000
STAFFORD.			
Hartwood township	Rappahannock	Deane No. 9 steam force-pump	

WYOMING.

SWEETWATER.			
California	Buckeye State	Steam force-pump	
Miner's Delight	Hartley	Cornish	500
Do	Miner's Delight	do	
Do	Segregated Miner's Delight	do	

Three principal methods are employed for extracting water from the mines, namely, Cornish pumps, bailing tanks, and steam (or compressed-air) force-pumps. The two last have the advantage over the first in point of cheapness, but the conveyance of steam to the bottom of the shafts involves waste of fuel, and the liberation of exhaust steam in the mines is very objectionable. Cornish pumps, on the other hand, are not only extremely expensive, but can only be repaired with the loss of considerable time. Tanks which are so constructed as to fill and to discharge automatically will handle an enormous quantity of water, and can be replaced by cages when not needed. They are too simple to get out of order often, and are readily repaired. Some mining engineers prefer them to pumps, and at many mines they are kept in readiness as a substitute for Cornish pumps when the rods of the latter break. An inspection of the table shows that local practice varies greatly as to the means adopted for handling water. Cornish pumps are more frequent in older mining districts than in newer ones, and in larger mines than in smaller ones.

Pumping is, on the whole, a much less important feature of mining engineering in the far West than in the East or in Europe. Mines of above 1,000 feet in depth sometimes need and have no means of disposing of water, and even the Comstock mines have less water to handle than some Belgian mines. In this respect the desert character of a large part of the mining regions of the West is distinctly advantageous.

DEEP MINES: CORNISH PUMPING RIGS.

ARIZONA.

YAVAPAI COUNTY.

TIGER DISTRICT: *Tiger.*—Cornish bob engine, horizontal, with fly-wheel, geared 5 to 1, 60 horse-power. Raises 1,500 gallons per hour, with maximum capacity of 4,500 gallons. Runs 7 hours in 24. Works jackhead pumps by a 350-feet rod. One counterbalance at surface.

CALIFORNIA.

AMADOR COUNTY.

AMADOR CITY DISTRICT: *Keystone Consolidated.*—Cornish pumping rig at south shaft driven by 80 horse-power vertical engine, which also hoists. In summer, pumps 4 hours in 24; in winter, constantly. Capacity, 14,000 gallons per hour. Rod, 1,000 feet. One 8-ton counterbalance at surface.

SUTTER CREEK DISTRICT: *Consolidated Amador.*—Cornish pumping rig driven by an 8-foot hurdy-gurdy wheel using 12 inches of water at 400 feet fall. Runs two-thirds of the time. Capacity, 3,500 gallons. Rod, 450 feet. One 3-ton counterbalance.

CALAVERAS COUNTY.

INDEPENDENCE DISTRICT: *Champion.*—Cornish pumping rig driven by a 40 foot overshot wheel, using 30 inches of water, which also hoists. Rod, 300 feet. Water raised to 300 feet level in buckets and then pumped.

MOKELUMNE HILL DISTRICT: *Gwin.*—Cornish pumping engine. Not in use at date of report. (Work transferred to upper levels. Water in the mine from the fifteenth to ninth level.)

EL DORADO COUNTY.

SPRINGFIELD, OR MUD SPRINGS DISTRICT: *Springfield.*—Cornish pumping rig driven by Morey's hurdy-gurdy, using in summer 24 inches of water (about 21 horse-power); in winter 35 inches (about 30 horse-power), with 400 feet fall. Capacity, 10,000 gallons per hour. Runs constantly. Rod, 410 feet. One 4-ton counterbalance. In winter, a Hooker pump, with a capacity of 10,000 gallons, is also used.

MARIPOSA COUNTY.

HORNITOS DISTRICT: *Washington.*—Cornish pumping engine, 60 horse-power. Runs constantly. Capacity, about 12,000 gallons per hour. Rod, 1,000 feet. Two counterbalances.

MONO COUNTY.

BODIE DISTRICT: *Booker Consolidated.*—Meyer's cut-off Cornish pumping engine, 75 horse-power. Runs constantly. Rod, 500 feet. Two counterbalances weighing 11 tons.

Champion.—Compound Cornish pumping engine. Runs constantly. Capacity, 22,500 gallons per hour. Double-acting, with two rods down to 400 feet and single rod for 200 feet below. One 10-ton counterbalance.

Standard Consolidated.—Cornish pumping engine. Runs constantly.

NEVADA COUNTY.

GRASS VALLEY DISTRICT: *Idaho.*—Cornish pumping engine, 110 horse-power. Runs constantly. Capacity, about 10,000 gallons per hour. Rod, 1,300 feet. Seven bobs, with counterbalances, weighing together 14 tons.

New York Hill.—Cornish pumping engine, 80 horse-power. Runs constantly, with varying length of stroke and speed. Rod, 1,300 feet. Two counterbalances, 2 tons each.

Rocky Bar.—Cornish pumping rig driven by water-power. Jackhead pumps operated by 400 feet of rod. One counterbalance.

NEVADA CITY DISTRICT: *Murchie.*—Cornish pumping engine, 30 horse-power. Runs constantly. Capacity, 7,000 to 10,000 gallons per hour. Rod, 250 feet. One 2-ton counterbalance.

Nevada City.—Cornish pumping engine, 25 horse-power. Runs constantly. Capacity, 6,000 to 10,000 gallons per hour. Rod, 350 feet. One 2-ton counterbalance.

Providence.—Cornish pumping engine, 30 horse-power. Runs nearly all the time, with varying length of stroke and speed. Rod, 900 feet. One bob.

PLACER COUNTY.

COLFAX DISTRICT: *Rising Sun.*—Cornish pumping rig driven by hoisting engine. Runs constantly. Capacity, about 30,000 gallons. Rod, 900 feet. One 4-ton counterbalance.

TUOLUMNE COUNTY.

CONFIDENCE DISTRICT: *Confidence.*—Cornish pumping rig driven by hoisting engine. Runs two-thirds of the time. Capacity, 6,000 to 7,000 gallons per hour; 500 feet force; 300 feet lift. One 1½-ton counterbalance.

SOULSBYVILLE DISTRICT: *Soulsby.*—Cornish pumping rig driven by hoisting engine. Runs half the time. Capacity, about 14,000 gallons per hour. Water and auxiliary steam-power. Rod, 460 feet. Two counterbalances.

COLORADO.

CLEAR CREEK COUNTY.

UPPER UNION DISTRICT: *Pioneer.*—Cornish pumping rig driven by mill engine. Pump runs 3 hours per day. Capacity, 3,600 gallons per hour. One Cornish plunger pump, 4-inch plunger, 4 feet stroke. Rod, 250 feet. One 800-pound counterbalance.

GILPIN COUNTY.

EUREKA DISTRICT: *Gunnell.*—Cornish pumping engine, 100 horse-power. Runs constantly at less than half capacity. Capacity at 10 strokes per minute, 9,600 gallons per hour. Rod, 800 feet. One 30-ton counterbalance.

GREGORY DISTRICT: *New York and Colorado.*—Cornish pumping rig driven by 60 horse-power engine, which also hoists and runs mill. Capacity, 3,000 to 4,000 gallons per hour. Rod, 800 feet. One counterbalance, 5 or 6 tons.

United Gregory.—Cornish pumping engine, 100 horse-power; horizontal, with fly-wheel. Capacity, 37,230 gallons per hour; raise, 700 feet. Working at one-fifth capacity. Cornish 14-inch pumps, run at 5 feet stroke, 3 strokes per minute. Rod, 700 feet. One 8-ton counterbalance.

NEVADA DISTRICT: *Kansas.*—Horizontal Cornish pumping engine, 40 horse-power. Runs constantly at less than half capacity. Full capacity, 9,000 gallons per hour. Rod, 1,100 feet. Two counterbalances—one at surface weighs 20 tons; one at 600 feet level, 10 tons.

RUSSELL DISTRICT: *Hazeltine.*—Horizontal Cornish pumping engine, 12 by 24 inch, 40 horse-power. Runs constantly. Capacity, 11,000 gallons per hour. Rod, 200 feet.

LAKE COUNTY.

CALIFORNIA DISTRICT: *Miner Boy.*—Cornish pumping rig. Not in use. Rod, 175 feet.

GEORGIA.

LINCOLN COUNTY.

[NO DISTRICT.] *Magruder.*—Cornish pumping rig driven by 20 horse-power hoisting engine. Uses about 3 horse-power (99,003.6 ft. lbs.). Runs 3 hours in 24. One Cornish draw and lift and one jackhead pump. Rod, 130 feet (60 feet wood and 70 feet iron). One ¼-ton counterbalance.

MERIWETHER COUNTY.

LUTHERVILLE DISTRICT: *Wilkes.*—Cornish pumping rig driven by 40 horse-power hoisting engine, which also runs a mill. Horizontal; 12 by 24 inches; eccentric valve. Runs 18 hours in 24; 6 hours with 3 feet stroke, pumping 2,520 gallons per hour, and 12 hours with a 2-foot stroke, pumping 1,680 gallons per hour. One Cornish pump. Rod, 70 feet. No counterbalances.

MAINE.

YORK COUNTY.

ACTON DISTRICT: *Acton Consolidated.*—Cornish pumping engine, 8 horse-power. Runs constantly. Rod, 160 feet. Two counterbalances weighing one-half ton.

MONTANA.

LEWIS AND CLARKE COUNTY.

OWYHEE DISTRICT: *Union No. 2.*—Horizontal Cornish pumping engine, 60 horse-power; slide valve with link motion. Runs one-tenth of the time. Capacity, 1,500 to 2,000 gallons per hour. Rod, 300 feet. One counterbalance, 3,500 pounds.

NEVADA.

ELKO COUNTY.

TUSCARORA DISTRICT: *Grand Prize.*—Horizontal Cornish pumping engine, 60 horse-power, geared 4 to 1; cylinder 18-inch diameter by 42-inch stroke. Engine makes 32 strokes per minute to 8 strokes of pump rod, working at 60 horse-power. Runs continuously. Can be run at 11 strokes per minute, pumping 21,450 gallons per hour. Rod, 500 feet. One surface bob, with 10 tons ballast. Water raised from 600 feet level to 500 feet level by steam force-pumps, whence it is raised by the Cornish pump.

ESMERALDA COUNTY.

ESMERALDA DISTRICT: *Real del Monte.*—Cornish pumping engine, 200 horse-power. Horizontal, 22 by 48, with very heavy fly-wheel 18 feet in diameter. Runs constantly. Capacity, 39,500 gallons per hour. Rod, 800 feet. One bob at surface, one at 420 feet, and one at 750 feet. Total weight of ballast, over 50 tons; one plunger pump at 420 feet, and one at 650 feet attached to main pump rod.

WILSON DISTRICT: *Wilson or Himalaya.*—Cornish pumping rig driven by direct connection with shaft of a 36 horse-power hoisting engine, which by belt connection also runs the battery. Rod, 195 feet. Water column, 3 inches. One counterbalance, 800 pounds.

LINCOLN COUNTY.

ELY DISTRICT: *Raymond & Ely.*—Cornish pumping engine. Rod, 1,200 feet. Three counterbalances.

NYE COUNTY.

PHILADELPHIA DISTRICT: *Belmont.*—Horizontal Cornish pumping engine, 60 horse-power. Works two 10-inch plunger pumps.

STOREY COUNTY.

AMERICAN FLAT DISTRICT: *Baltimore Consolidated.*—Cornish pumping engine, not in use. Horizontal, 26 by 72 inches, with fly-wheel, geared. When in use, ran 16 to 18 hours in 24. Rod, 1,900 feet. Three bobs, with 25 tons ballast each.

GOLD HILL DISTRICT: *Alta.*—Horizontal Cornish pumping engine, power stated at 500 horse-power; compound, with differential valve gear. Runs constantly. Capacity, 30,000 gallons per hour; double plunger pumps. Rods, 1,900 feet, double, counterbalancing each other.

Belcher & Crown Point pump shaft.—Compound beam Cornish pumping engine. High pressure cylinder, 30 inches diameter by 10 foot stroke; expansion cylinder, 62½ inches diameter by 8 feet stroke; average vacuum, 22 inches; steam, 110 pounds; average number of strokes, 4 per minute. Can be run as slowly as one stroke in 2 minutes, having Davy's differential valve motion. Power stated at 250 horse-power. Runs constantly, except when stopped for repairs, such as breaking of pump rod, etc. Capacity at four strokes per minute, 14,400 gallons per hour; has been run at 8 strokes per minute, pumping 28,800 gallons per hour to surface, but should not exceed 6 strokes, pumping 21,600 gallons per hour to surface; 21 single-acting Cornish plunger pumps. The 11 upper pumps are 14 inches diameter by 8 feet stroke, and the 10 lower ones are 10 inches diameter by 8 feet stroke. Water column, 14 inches diameter. Rod, 900 feet vertical, 14 by 16 inches; 2,667 feet at angle of 35°, 12 by 12 inches, and 784 feet at same angle, 9 by 9 inches; total length, 4,351 feet. Rod made of Oregon pine, bound with iron straps, 10 by 1 inches. Seven balance bobs, with 25 tons ballast each; also one V-bob, making connection between vertical shaft and incline. This engine cost at foundery $250,000.

Caledonia.—Cornish pumping engine. Power stated at 200 horse-power. Horizontal, high pressure, double geared, with Corliss bed. Runs from 12 to 14 hours in 24. Capacity at 5 strokes per minute 14,100 gallons per hour. Cornish plunger pumps, 12 inches diameter by 8 feet stroke. Rod, 1,600 feet long; single joints, 30 feet. Pump stations at intervals of 200 feet. Four counterbalances, averaging 25 tons each.

Consolidated Imperial.—Horizontal Cornish pumping engine, geared 5 to 1. Power stated at 200 horse-power. Runs 22 hours in 24. Capacity, 6,500 gallons per hour to surface—much greater to tunnel level. Cornish plunger pumps. Rod 2,400 feet long (part on incline). Six balance bobs, 15 tons ballast each.

Forman shaft.—Inverted beam, direct-acting, compound Cornish pumping engine. Gravitation jet condenser, with separate air-pump. Power stated at 600 horse-power. Runs constantly at partial capacity, except when stopped for repairs. Averaged 11,292 gallons per hour, including stops, for 3 months, pumping to surface. Full capacity much greater. Rod, 1,250 feet June 1, 1880, 1,980 feet May 1, 1881; extended as shaft is sunk. Four counterbalances, 20 tons each.

Justice.—Horizontal, geared, Cornish pumping engine, with fly-wheel. Cylinder, 24 by 48; not running in census year. Seven Cornish plunger pumps, 12-inch diameter by 8 feet stroke. Rod, upper 400 feet, 14 by 14 inches; 300 feet, 12 by 12 inches; and incline rod 10 by 10 inches, connected by V-bob at bottom of vertical shaft. Two counterbalances, one 20 tons and one 30 tons.

Silver Hill.—Cornish pumping engine, 24-inch diameter by 20-inch stroke, with automatic cut-off. Power stated at 300 horse-power. Runs constantly. Capacity, 18,000 gallons per hour. Rod, 444 feet. One balance bob, with 30 tons ballast.

Yellow Jacket.—Compound Cornish pumping engine. High-pressure cylinder, 31 inches diameter by 12 feet stroke; low pressure cylinder, 62 inches diameter by 12 feet stroke. Uses 100 pounds steam cut-off at half stroke, working at 400 horse-power. Runs constantly at 5 strokes per minute, except when stopped for repairs, and at this speed in the census year raised to the surface 80 gallons per stroke, or 24,000 gallons per hour. Subsequent to connection with Sutro tunnel, raised 1,500 feet to that level, 160 gallons per stroke, or 48,000 gallons per hour. Can be run at seven strokes per minute, giving a capacity of 67,200 gallons per hour. Double line of Cornish plunger pumps. Rod, 3,020 feet long. Ten balance bobs, ballasted with 20 to 22 tons each at even leverage. This engine cost at foundery $230,000.

VIRGINIA DISTRICT: *Consolidated Virginia and California joint shaft.*—Direct-acting compound Cornish pumping engine. High-pressure cylinder, 26 inches diameter by 8 feet stroke; expansion cylinder, 40 inches diameter by 8 feet stroke. Works at 60 horse-power per stroke, 6 to 8 strokes per minute; 360 to 480 horse-power. Capacity very slightly in excess of 480 horse-power. Runs constantly. At 8 strokes per minute, 80 gallons per stroke, raises 38,400 gallons per hour, 950 feet to Sutro tunnel level. Single rod and double line of water column. Rod, 2,520 feet long. Eight balance bobs, with 20 tons ballast each at even leverage.

Combination shaft (Chollar, Potosi, Hale & Norcross, and Savage joint shaft).—Compound Cornish pumping engine, 600 horse-power. Ran constantly during census year. Capacity, 60,000 gallons per hour. Rod, 2,500 feet, 15 inches square. Seven balance bobs, with 30 tons ballast each. In April, 1881, the new hydraulic pump was placed in position. This was guaranteed to have a capacity of 96,000 gallons per hour. Fitted with double-action barrel force-pumps at bottom of shaft, operated by hydraulic pressure, applied at the surface.

Hale & Norcross.—Vertical compound Cornish engine. Power stated at 350 working horse-power. Stops only for repairs. Capacity, 19,740 gallons per hour. Rod, 3,100 feet long, partly on incline; averages 14 inches square. Seven balance bobs, with 20 tons ballast each.

Ophir.—Horizontal Cornish pumping engine, with fly-wheel. Working at 100 horse-power; extreme power stated at 300 horse-power. Runs constantly. At four strokes per minute raises 10,800 gallons per hour, 900 feet lift, to Sutro tunnel level. Extreme capacity, 21,600 gallons. Rod, 1,500 feet vertical and 1,700 feet in incline. Connected by a V-bob. Eight balance bobs, with 20 tons ballast each; six in vertical shaft, and 2 in incline.

Osbiston shaft (Gould & Curry and Best & Belcher joint shaft).—Compound, direct-acting Cornish pumping engine, Davy's differential valve motion, with fly-wheel. Power stated at 500 horse-power. Runs constantly, except when stopped for repairs. Capacity, 24,000 gallons per hour; raises to Sutro tunnel level. Rod, 1,900 feet long, 16 inches square. Seven balance bobs, 17 tons ballast each.

Savage.—Horizontal, low-pressure, direct-acting Cornish pumping engine. Power stated at 450 horse-power. For six months ran 24 hours per day. Capacity, 30,000 gallons per hour; working at 26,500 gallons per hour; raises to Sutro tunnel level. Rod, 2,600 feet long, partly on incline. In vertical shaft rod is 14 inches square; in incline, 12 inches square. Ten balance bobs, with 20 tons ballast each.

Sierra Nevada.—Horizontal Cornish pumping engine, with fly-wheel. Power stated at 175 horse-power. Not used since May, 1880. Capacity, 22,000 gallons per hour. Rod, 1,700 feet. Three balance bobs, with 18 to 20 tons ballast each.

Union shaft (Sierra Nevada, Union Consolidated and Mexican joint shaft).—Compound Cornish pumping engine. High-pressure cylinder, 64 inches diameter by 81 inches stroke; expansion cylinder, 100 inches diameter by 99 inches stroke. Very heavy fly-wheel. Working at 270 horse-power; half capacity. Runs constantly at 4¼ to 4½ strokes per minute. At half capacity raises 41,580 gallons per hour 1,100 feet from sump to 100 feet above Sutro tunnel level. Double line of column. Pumps, 14 inches diameter by 10 feet stroke. Eight balance bobs, ballasted with 18 to 20 tons each at equal leverage.

Utah.—Horizontal, geared, Cornish pumping engine, with fly-wheel. Power stated at 150 horse-power. Runs 9 hours in 24. Capacity, 12,300 gallons per hour. Rod, 2,600 feet long, partly in incline; in vertical shaft, 12 inches square; in incline, 10 inches square. Five balance bobs, ballasted with 14 tons each.

NORTH CAROLINA.

DAVIDSON COUNTY.

EMMONS TOWNSHIP: *Silver Valley.*—Cornish pumping engine, 108 horse-power. Ran constantly during census year. Subsequently discontinued. Capacity, 29,700 gallons per hour. Stated that it can be run 30 strokes per minute. Length of rod, 160 feet. One counterbalance, 1,400 pounds. Two steam force-pumps now used.

[NO DISTRICT.] *Ethan Allen.*—Cornish pumping engine, 15 horse-power. Runs 3 hours per day. Rod, 80 feet.

GASTON COUNTY.

[NO DISTRICT.] *King's Mountain.*—Horizontal Cornish pumping engine, 50 horse-power. Runs constantly. Capacity at full stroke, 15 strokes per minute, 17,846 gallons per hour. Cornish plunger and upper drawing lift pumps. Rod, 325 feet. One 2-ton counterbalance.

MECKLENBURG COUNTY.

CAPP'S HILL DISTRICT: *McGinn.*—Cornish pumping rig, driven by 40 horse-power hoisting engine. Runs constantly. Capacity, 9,399 gallons per hour. One Cornish drawing lift. Rod, 110 feet. One 1,500-pound counterbalance.

SIXTH DISTRICT: *Rudisill.*—Horizontal double-acting Cornish pumping engine, with fly-wheel, 40 horse-power. Runs constantly. One Cornish plunger and up-drawing lift-pump. Rod, 200 feet. One 3-ton counterbalance.

VIRGINIA.

BUCKINGHAM COUNTY

CURDSVILLE DISTRICT: *Morrow.*—Horizontal Cornish pumping engine, with fly-wheel, 20 horse-power. Also hoists and runs mill. Runs constantly. Capacity, 7,200 gallons per hour. Rod, 72 feet. One 1,600-pound counterbalance.

FAUQUIER COUNTY.

[No district.] *Kelley.*—Cornish pumping rig driven by 25 horse-power hoisting engine. Runs constantly on week days and 3 to 3½ hours on Sunday. One Cornish jackhead pump. Capacity, about 3,000 gallons per hour. Rod, 120 feet (about).

LOUISA COUNTY.

Coohoo district: *Luce Bros.*—Cornish pumping rig driven by 14 horse-power hoisting engine. Runs constantly. Cornish upper drawing lift. Capacity, 3,600 gallons per hour. Rod, 100 feet. One 800-pound counterbalance.

WYOMING.

SWEETWATER COUNTY.

Miner's Delight district: *Hartley.*—Cornish pumping rig driven by 40 horse-power hoisting engine, which also runs mill.
Miner's Delight.—Cornish pumping rig driven by 40 horse-power hoisting engine. One 8-inch pump.
Segregated Miner's Delight.—Cornish pumping rig driven by 50 horse-power engine. This engine also runs battery and hoists. Pumps constantly.

TABLE XXIX.—DEEP MINES: POWER DRILLS.

State or territory.	Number of mines reported using power drills.	Percussion drills in use.	Diamond drills in use.
Total	65	250	7
Arizona	1	1	.....
California	11	16	.....
Colorado	10	26	.....
Dakota	2	2	1
Idaho	2	2	.....
Maine	4	6	.....
Montana	1	1	.....
Nevada	30	189	6
Utah	2	3	.....
Virginia	2	4	.....

In spite of the numerous improvements made in power drills, their use in the West is still limited. Percussion drills are distinctly advantageous where large tunnels are being driven, and where, consequently, there is ample space to handle them. They are also useful in running mine drifts not much in excess of the ordinary size when for any reason a high rate of progress is called for, but the ordinary work of the mines is usually performed by hand.

Diamond drills are sometimes used in prospecting for ore, but more frequently in exploring ahead of the face of a drift or shaft for water where there is danger of a serious influx.

Considerably more than one-half of the drills reported are in use on the Comstock lode, where the conditions are peculiarly suited to them. Besides the Sutro tunnel, there are many drifts and large shafts where drills have ample space. The heat as well as the large size of the ore-bodies of the lode require a high rate of progress in pushing galleries, and the disastrous floods which have so often occurred demand the precaution of running diamond drills ahead of many workings.

TABLE XXX.—DEEP MINES: AIR COMPRESSORS AND BLOWERS OR FANS.

State or territory.	Number of mines reported.	Number of compressors and blowers.	Number in use.
Total	101	140	125
Arizona	4	4	4
California	24	32	29
Colorado	16	23	17
Dakota	2	4	4
Idaho	2	2	1
Maine	4	4	4
Montana	1	1	1
Nevada	33	53	51
New Mexico	1	1	1
North Carolina	2	2	2
Utah	11	13	10
Virginia	1	1	1

The many varieties of machines for furnishing air for driving machinery or for ventilation in underground workings are grouped under one head. The compressed-air exhaust from machines such as power drills, baby hoists, etc., is an effective ventilating agent as well as a motive power.

The heading "Number of mines reported" means mines coming within the standard reported as having compressors. The total number of compressors, etc., stated is probably between 80 and 90 per cent. of the true total. There are a few in idle (unreported) works of Owyhee county, Idaho, and on the Comstock. Some of the compressors have capacity for driving 50 horse-power winze engines.

Few of the deep precious-metal mines require particularly active ventilation. The force of men employed is smaller than in the mines of base metals, where the value of the ore per ton is smaller and the breasts larger, while there is nothing corresponding to the fire-damp and choke-damp of the coal mines. On the Comstock lode, indeed, the high temperature, while necessitating active ventilation, also promotes it. While the natural ventilation, skillfully adjusted, is sufficient for the workings through which a draft can be made, it is frequently necessary to supply air by mechanical means to the headings of drifts. For this purpose the simpler forms of fans, often constructed on the spot, are generally sufficient.

TABLE XXXI.—DEEP MINES: MISCELLANEOUS ENGINES.

State or territory and county.	Number of mines reported having engines other than for hoisting or pumping.	Number.	Number in use.	Horse-power.
CALIFORNIA.				
Calaveras	1	1	1	15
Inyo	1	1	1	12
Mono	4	4	4	a 35
Nevada	1	2	2	a 20
Siskiyou	1	1	1	4
COLORADO.				
Clear Creek	2	2	1	26
Custer	1	1	1	30
Gilpin	1	1	1	25
Lake	2	2	2	45
Ouray	1	1	1	a 3
San Juan	1	1	1	1
DAKOTA.				
Lawrence	2	7	7	90
GEORGIA.				
Cobb	1	1	1	a 3
Forsyth	1	1	1	a 3
Lincoln	1	1	1	a 3
McDuffie	1	1	1	a 15
Meriwether	1	1	1	60
IDAHO.				
Alturas	1	1	1	15
Boisé	1	1	1	25
MAINE.				
Hancock	1	1	1	a 20
NEVADA.				
Eureka	3	3	3	44
Nye	1	1	1	6
Storey	22	56	54	1,053
White Pine	2	2	2	25
NORTH CAROLINA.				
Davidson	1	1	1	5
Gaston	1	2	2	27
Stanley	1	2	2	27
VIRGINIA.				
Buckingham	1	1	1	a 10

a Estimated.

TABLE XXXII.—DEEP MINES: MISCELLANEOUS ENGINES.

RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	No. of mines.	Miscellaneous engines.	In use.	Horse-power.
Total	58	100	97	1,647
California	8	9	9	86
Colorado	8	8	7	130
Dakota	2	7	7	90
Georgia	5	5	5	84
Idaho	2	2	2	40
Maine	1	1	1	20
Nevada	28	62	60	1,128
North Carolina	3	5	5	59
Virginia	1	1	1	10

The tables include only the deep mines coming within the standard. Of the 58 mines so reported, 28 are in Nevada, and 22 of these latter, having an aggregate of 1,053 horse-power, are on the Comstock. The tables, except for the Comstock, are probably very deficient, no "other" engines being reported from Montana or Utah. The following classes are included:

Saw and carpenter-shop engines	22
Machine-shop, blacksmith-shop, and foundery engines	14
Steam-hammers	3
Blower engines	32
Compressed-air winze engines	13
Various	14
Unclassified	2
	100

Among the number classed as "various" are traction engines, for hauling cars, timber, etc., uphill to the shafts, small feed-pumps, engine for handling steel-hoisting cable while repairing, etc.

The average rating of "other" engines is 10½ horse-power. They include various types, from small donkey and vertical engines to horizontal engines of considerable power. Among the compressed-air winze engines several are of considerable magnitude, ranging to 50 horse-power for a single underground hoisting rig.

TABLE XXXIII.—DEEP MINES: BOILERS.

State or territory and county.	Number of mines reported having boilers.	Number of boilers.	Number in use.
ARIZONA.			
Maricopa	2	2	2
Mohave	2	2	1
Pima	6	7	7
Pinal	1	1	1
Yavapai	2	2	2
CALIFORNIA.			
Amador	7	19	14
Calaveras	2	3	3
El Dorado	2	3	3
Inyo	2	3	2
Mariposa	1	2	2
Mono	24	35	31
Nevada	7	15	15
Placer	1	2	2
Plumas	1	1	1
Siskiyou	1	2	2
Tuolumne	2	3	3
COLORADO.			
Boulder	15	22	22
Clear Creek	16	20	17
Custer	4	8	8
Gilpin	28	49	42
Hinsdale	1	2	2
Lake	24	50	49
Ouray	1	2	2
San Juan	3	4	4
Summit	1	2	2
DAKOTA.			
Lawrence	5	12	12
GEORGIA.			
Cherokee	1	1	1
Cobb	1	1	1
GEORGIA—continued.			
Forsyth	1	1	1
Hall	1	1	1
Lincoln	2	2	2
McDuffie	1	2	2
Meriwether	1	1	1
IDAHO.			
Alturas	2	2	2
Boise	2	4	4
Lemhi	1	1	.....
Owyhee	6	6	6
MAINE.			
Hancock	6	9	9
Penobscot	1	1	1
Washington	1	1	1
York	1	1	1
MONTANA.			
Beaver Head	1	2	2
Deer Lodge	10	19	17
Jefferson	1	1	1
Lewis and Clarke	1	7	7
NEVADA.			
Elko	6	11	10
Esmeralda	6	10	10
Eureka	10	17	17
Lander	1	2	2
Lincoln	2	9	9
Nye	5	8	7
Storey	28	187	151
White Pine	4	6	6
NEW HAMPSHIRE.			
Coos	1	1	1
NEW HAMPSHIRE—continued.			
Grafton	1	1	1
NEW MEXICO.			
Grant	2	2	2
NORTH CAROLINA.			
Davidson	4	8	4
Gaston	1	3	1
Guilford	1	1	1
Mecklenburg	2	3	3
Moore	1	1	1
Nash	1	1	1
Rowan	1	4	2
Stanley	1	2	1
OREGON.			
Baker	2	5	5
UTAH.			
Beaver	2	3	1
Juab	1	1	1
Salt Lake	11	14	9
Summit	3	19	17
Tooele	4	4	4
Wasatch	3	5	4
Washington	4	5	5
VIRGINIA.			
Buckingham	1	1	1
Culpeper	1	1	1
Fauquier	1	1	1
Louisa	1	1	1
Stafford	1	1	1
WYOMING.			
Sweetwater	3	5	5

TABLE XXXIV.—DEEP MINES: BOILERS.

RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	Number of mines reported having boilers.	Number of boilers.	Number in use.
Total	318	679	597
Arizona	13	14	13
California	50	88	77
Colorado	98	159	148
Dakota	5	12	12
Georgia	3	9	9
Idaho	11	13	12
Maine	9	12	12
Montana	13	29	27
Nevada	62	250	212
New Hampshire	2	2	2
New Mexico	2	2	2
North Carolina	12	23	15
Oregon	2	5	5
Utah	28	51	41
Virginia	5	5	5
Wyoming	3	5	5

TABLE XXXV.—DEEP MINES: CHARACTER OF BOILERS.

State or territory.	Total number of boilers reported.	Horizontal boilers.	Vertical boilers.	Character unspecified.
Total	679	546	93	40
Arizona	14	7	5	2
California	88	80	5	3
Colorado	159	92	48	19
Dakota	12	9	2	1
Georgia	9	4	2	3
Idaho	13	10	3	.....
Maine	12	4	8	.....
Montana	29	23	.....	6
Nevada	250	240	8	2
New Hampshire	2	1	1	.....
New Mexico	2	1	1	.....
North Carolina	23	21	2	.....
Oregon	5	5	.....	.....
Utah	51	39	8	4
Virginia	5	5	.....	.....
Wyoming	5	5	.....	.....

These tables include possibly 90 per cent. of the boilers of the actively working mines, but not those of the idle works. There are several such on the Comstock; in the Carson district, Idaho; and in the Tuscarora, Ely, Cornucopia, and other districts in Nevada.

It did not prove practicable to draw any broad distinction except between upright and horizontal boilers from the schedule returns. There are comparatively few simple cylindrical boilers, the great majority being furnished either with flues or with small fire tubes, while there are a few water-tube boilers and a considerable variety of unusual styles. While simplicity of construction is very desirable in the western mining districts, many of them being at great distances from machine-shops, the high price of fuel necessitates economy in its use. But for this fact it is probable that the simpler forms of boiler would greatly predominate over those of the locomotive type. The expense of freight, however, often influences the selection. A locomotive boiler presents much more steam surface in proportion to its weight than those of the egg-end type, thus tending to counterbalance the difference in the original cost.

TABLE XXXVI.—DEEP MINES: COST OF PLANT.

State or territory and county.	Mines reporting cost of plant.	Cost.
ALABAMA.	*No.*	*Dollars.*
Cleburne	1	100
ARIZONA.		
Maricopa	5	33,190
Mohave	1	1,700
Pima	10	45,927
Pinal	3	12,000
Yavapai	2	47,000
CALIFORNIA.		
Amador	5	155,000
Calaveras	2	48,000
El Dorado	2	16,000
Inyo	5	180,500
Mariposa	4	7,100
Mono	24	583,092
Nevada	6	108,000
Placer	1	20,000
Plumas	1	2,500
Siskiyou	3	84,270
Tuolumne	2	38,000
COLORADO.		
Boulder	12	40,300
Clear Creek	21	182,590
Custer	3	10,000
Gilpin	32	269,653
Hinsdale	1	4,091
Lake	22	221,179
Ouray	2	27,000
San Juan	1	15,000
Summit	1	7,000
DAKOTA.		
Lawrence	4	116,975
GEORGIA.	*No.*	*Dollars.*
Cherokee	1	950
Cobb	1	3,000
Forsyth	1	4,500
Hall	1	2,700
Lincoln	2	8,700
McDuffie	1	8,500
Meriwether	1	6,000
IDAHO.		
Alturas	4	37,600
Boisé	3	22,800
Lemhi	2	50,400
Owyhee	2	30,000
MAINE.		
Hancock	4	148,500
Penobscot	1	2,500
Washington	1	2,500
York	1	4,000
MONTANA.		
Beaver Head	1	a 7,000
Deer Lodge	10	130,700
Jefferson	1	6,000
Lewis and Clarke	1	250,000
NEVADA.		
Elko	10	183,750
Esmeralda	9	150,500
Eureka	10	100,000
Lincoln	2	249,774
Nye	4	38,000
Storey	31	6,687,639
White Pine	3	a 22,300
NEW HAMPSHIRE.		
Coos	1	4,000
NEW MEXICO.	*No.*	*Dollars.*
Grant	2	11,000
Santa Fé	1	1,400
NORTH CAROLINA.		
Davidson	4	28,270
Gaston	1	38,000
Guilford	1	1,200
Mecklenburg	2	21,000
Moore	1	2,500
Nash	1	10,000
Rowan	1	30,000
Stanley	1	6,000
OREGON.		
Baker	2	90,000
Josephine	1	200
UTAH.		
Beaver	3	42,030
Juab	5	7,100
Salt Lake	13	237,000
Summit	5	277,750
Tooele	7	57,000
Utah	2	1,500
Wasatch	4	60,000
Washington	5	23,450
VIRGINIA.		
Buckingham	1	8,000
Culpeper	1	1,500
Fauquier	1	3,200
Louisa	1	800
Stafford	1	a 6,000
WYOMING.		
Sweetwater	3	48,000

a Estimated.

TABLE XXXVII.—DEEP MINES: COST OF PLANT.

RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	Number of mines reporting cost of plant.	Cost.
Total	363	$11,459,609
Alabama	1	100
Arizona	20	139,617
California	55	1,343,082
Colorado	95	776,722
Dakota	4	116,975
Georgia	8	34,350
Idaho	11	140,800
Maine	7	157,500
Montana	22	293,700
Nevada	69	7,439,563
New Hampshire	1	4,000
New Mexico	3	13,400
North Carolina	12	137,070
Oregon	3	90,200
Utah	44	705,850
Virginia	5	19,500
Wyoming	3	48,000

In many cases, especially where mines have been purchased, the cost of plant has not been discriminated from the value of the mine, and the present owners are, in fact, ignorant of the prices originally paid for buildings and machinery. As a consequence, Tables XXXVI and XXXVII are less complete than most of the others. Only 363 mines are returned under this head, reporting a total cost of plant of $11,459,609, or an average of nearly $32,000 each. Considering the number of large mines not reported, it is probable that the total given is not more than one-fifth of the actual total. Among the mines omitted in the table are the following:

ARIZONA.—Several important mines in Tombstone district.

CALIFORNIA.—In Bodie district, Mono county, the Bodie Consolidated, Boston Consolidated, Dudley, Jupiter, Noonday, North Noonday, and others. In Nevada City district, Nevada county, the Murchie mine. Confidence district, in Tuolumne county, the Confidence mine. Also several scattered districts.

COLORADO.—In Boulder county, the Smuggler mine, Central district; the Cold Spring, Melvina, and others, in Gold Hill district; the Boulder County and Trojan, Caribou and Horsefall mines in Grand Island district, and the Niwot mine, Ward district. In Clear Creek county, Downieville district and the Red Elephant mine; the Equator, Griffith district; the Pioneer, Upper Union district; York district and the Clifford mine. In Custer county, the Bull-Domingo, Hardscrabble district. In Gilpin county, the Bobtail, of Gregory district, and the Pewabic, of Russell district. In California district (Leadville), Lake county, the Adelaide, Colorado Prince, Iron, Leadville Consolidated, and other mines. In San Juan county, the Adelphi mine, of Eureka district.

DAKOTA.—The Sir Roderick Dhu and other mines in Whitewood district, Lawrence county.

IDAHO.—The idle plant of Carson, Flint, and South Mountain districts, Owyhee county.

MAINE.—The Goldsboro' mine, Goldsboro' district, and the Ashley mine, Sullivan district, both in Hancock county.

NEW HAMPSHIRE.—The Little May, Ammonoosuc district, Grafton county.

NEVADA.—In Elko county, the various idle works of Cornucopia district. Cortez district and the Garrison mine, Eureka county; and the Eureka Consolidated and Richmond mines, of Eureka district, in the same county. In Lander county, the Ætna mine, of Battle Mountain district; the Starr & Grove mine, of Lewis district, and the Curtis mine (Manhattan Mining Company) in Reese River district. In Lincoln county, the Hillside mine, in Bristol district, and the Raymond & Ely and other mines, in Ely district. In Nye county, the Belmont mine, Philadelphia district. In Storey county, all the idle and abandoned works of the Comstock, with the exception of works which, though idle at the time of report, were in serviceable condition and were liable to be actively operated again. In White Pine county, the Tikup mine, Cherry Creek district, and the Paymaster (Martin White Mining Company), Ward district. The Eberhardt & Aurora mine, White Pine district, in the same county, was also omitted.

WYOMING.—The Hartley mine, Miner's Delight district, Sweetwater county.

LABOR AND WAGES.

TABLE XXXVIII.—DEEP MINES: PERSONNEL.

State or territory.	PERSONNEL.					Number of mines reported.
	Total.	Staff.	Foremen.	Miners.	Surface men.	
The United States	19,147	732	635	13,770	4,010	606
Alabama	17	1	2	7	7	2
Arizona	853	54	42	573	184	53
California	3,159	68	75	2,291	730	87
Colorado	6,130	192	213	4,522	1,194	155
Dakota	960	66	32	604	258	58
Georgia	145	10	10	60	65	10
Idaho	481	35	29	317	50	34
Maine	131	9	12	74	36	8
Montana	1,164	32	61	771	300	67
Nevada	3,550	138	84	2,713	615	88
New Hampshire	36	2	1	21	2	3
New Mexico	215	8	13	150	44	13
North Carolina	529	21	14	309	185	12
Oregon	118	8	6	80	22	9
Utah	1,530	86	42	1,143	259	62
Virginia	105	3	3	73	26	5
Washington	7	.....	1	2	4	1
Wyoming	80	4	5	60	20	7

The present examination could not result in ascertaining the total number of miners employed in the deep precious-metal mines, since only those reaching a certain standard were taken into consideration. Table XXXVIII, therefore, probably represents not more than two-fifths of those who habitually gain their livelihood by mining. Indeed, in considerable areas, especially in most parts of the Great Basin, almost the whole population is either directly or indirectly dependent upon the mines for support. The table, however, serves to illustrate the numerical relations which the different classes of employés bear to one another. The preponderance of the staff over foremen is to be accounted for by the fact that in many comparatively small mines the superintendent acts as foreman, although not participating in the manual labor, while, in large mines, there is often a considerable staff of clerks, assayers, etc., in addition to the superintendent.

TABLE XXXIX.—DEEP MINES: LABOR AND WAGES.

State or territory.	LABOR.			WAGES.		
	Total hours' work during the year.	Number of mines reported.	Average hours' work per mine.	Total amount paid on labor account, exclusive of staff.	Number of mines reported.	Average amount paid for labor per mine.
The United States	51,965,536	656	79,216	$13,261,353	580	$21,140 28
Alabama	11,700	2	5,850	835	2	417 50
Arizona	1,473,687	43	34,388	440,302	43	10,241 67
California	10,087,316	75	134,498	1,554,408	59	21,430 64
Colorado	19,119,099	198	96,561	3,983,827	177	20,699 50
Dakota	1,688,528	55	30,701	576,905	49	11,775 41
Georgia	228,020	10	22,802	16,934	8	2,116 75
Idaho	678,214	30	22,607	254,866	28	9,102 35
Maine	253,000	7	36,143	22,077	4	5,519 25
Montana	2,886,904	59	49,134	804,686	42	19,159 19
Nevada	10,106,555	70	144,412	3,200,476	62	51,765 74
New Hampshire	13,500	1	13,500	4,625	2	2,312 50
New Mexico	363,541	12	30,295	83,955	11	7,632 27
North Carolina	1,131,390	12	94,283	64,367	11	5,851 55
Oregon	208,080	9	23,120	62,080	8	8,508 63
Utah	9,543,134	67	52,957	1,162,971	66	17,396 63
Virginia	144,728	5	28,946	11,310	5	2,262 00
Washington	3,840	1	3,840	1,560	1	1,560 00

The average pay, as deduced from the returns, is 26.7 cents an hour, or, say, $2 67 a day of ten hours. Under "surface men" in Table XXXVIII various classes are included, such as blacksmiths, carpenters, and other mechanics, as well as unskilled laborers, and the average price paid to this class, therefore, varies very greatly. The wages paid to the miners per shift, on the other hand, are pretty regular over extensive areas, as Table XL shows. They are highest in the Great Basin, but lower in Utah than in Idaho, Nevada, and Arizona on account of the presence of Mormon settlements. Mormons seldom become miners, but furnish the mining population with supplies and transportation cheaper than these necessaries can be furnished in the western portion of the basin. The hours of labor vary much more than the wages, though ten hours is the usual day's work. The ordinary length of shift on the Comstock lode, where the work is extremely trying on account of the high temperature, is eight hours, but is often reduced to six hours for men employed in excessively hot places. Eight-hour shifts are in use away from the Comstock in a considerable number of mines where it is desirable, for any reason, to press the work; but it is well understood that the night shift is less efficient than the others. The mines in which the men are called upon to work twelve hours are few in number, and most of them are in the southern states.

In estimating the total amount of wages paid to deep precious-metal miners it must be remembered that very few of them are never out of work. In most camps there is always a large number of men who, though miners by occupation, are temporarily idle. It is not probable that the 50,000 miners (estimated) actually receive more than an average of $2 per day each for 300 days, or in the aggregate $30,000,000 per annum.

TABLE XL.—DEEP MINES: USUAL WAGES PER SHIFT OF MINERS AND FOREMEN.

State or territory.	Miners.	Foremen.
Alabama	$1 00	$1 00
Arizona	4 00	5 00
California	3 25	5 00
Colorado	3 00	5 00
Dakota	3 50	5 50
Georgia	1 00	2 00
Idaho	4 00	5 00
Maine	1 50	2 00
Montana	3 50	5 00
Nevada	4 00	6 50
New Hampshire	1 50	3 00
New Mexico	2 75	4 50
North Carolina	1 00	2 00
Oregon	3 00	4 00
Utah	3 25	5 00
Virginia	1 25	1 25
Washington	2 50	.....
Wyoming	3 00	4 00

The wages given in this table are representative. They were obtained as averages, but the expression of odd cents would complicate the data without serving any useful end.

TABLE XLI.—DEEP MINES: NUMBER OF MEN EMPLOYED IN THE COMSTOCK MINES IN 1860.

Mine.	Total number employed.	Blacksmiths.	Blacksmiths' helpers.	Boiler-makers.	Bosses.	Brakemen.	Bricklayers.	Car-men.	Carpenters.	Cooks.	Engineers.	Firemen.	Foremen.	Fuse-makers.	Harness-makers.	Hostlers.	Laborers.	Lumpmen.
Total	2,840	68	27	7	44	6	2	21	93	1	162	80	34	1	1	1	194	2
Alta	74	3	3	..	....	....	....	....	1	....	10	3	3	1	....	....	....	....
Andes	13	1	....	....	....	....	....	....	1	....	2	....	1	....	....	....	1	....
Belcher	93	4	2	....	5	....	....	....	3	....	10	3	1	....	....	....	2	....
Best & Belcher	50	2	....	....	....	....	....	....	1	....	4	3	1	....	....	....	4	....
Bullion	40	1	....	....	....	....	....	....	1	....	2	2	1	....	....	....	....	....
Caledonia	17	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....
Consolidated Imperial	75	2	....	....	2	....	....	....	2	....	2	3	1	....	....	....	1	....
Consolidated Virginia and California (C. & C. shaft)	351	4	4	2	3	3	....	....	7	....	13	5	1	....	....	....	3	1
Crown Point and Kentuck	30	....	....	....	2	....	....	....	....	....	3	1	....	....	....	....	1	....
C. N. S. shaft	66	3	....	....	....	....	2	....	2	....	8	3	2	....	....	....	3	....
Forman shaft	37	1	2	....	....	....	....	....	2	....	6	2	1	....	....	....	2	....
Gould & Curry	50	2	....	1	3	....	....	....	2	....	3	3	1	....	....	....	3	1
Hale & Norcross	66	2	....	....	....	....	....	....	1	....	7	2	1	....	....	....	2	....
Julia	54	2	....	....	....	....	....	....	1	....	6	3	3	....	....	....	2	....
Justice	37	....	....	....	2	....	....	....	....	....	....	....	1	....	....	....	....	....
Lady Bryan	31	2	....	....	....	....	....	....	1	....	3	....	2	....	....	....	3	....
Mexican and Union shaft	480	4	4	....	3	3	....	13	24	....	7	4	1	....	....	....	36	....
Mint	11	....	....	....	....	....	....	....	....	....	2	....	1	....	....	....	2	....
New York	26	2	....	....	....	....	....	....	....	....	3	3	....	....	....	....	3	....
North Bonanza and Flowery	51	2	....	....	3	....	....	....	2	....	3	3	....	....	....	....	2	....
Ophir	380	2	3	3	3	....	....	....	7	....	15	6	1	....	....	....	8	....
Original Keystone	21	2	1	....	3	....	....	2	2	....	3	....	1	....	....	....	2	....
Osbiston shaft	39	1	1	....	3	....	....	3	2	....	3	10	1	....	....	....	4	....
Overman	46	2	....	1	....	....	....	....	1	....	4	2	....	....	....	....	....	....
Occidental	17	3	....	....	....	....	....	....	1	1	2	....	1	....	....	....	1	....
Savage	68	2	1	....	3	..	....	....	2	....	5	3	1	....	....	....	....	....
Scorpion	40	1	....	....	....	....	....	....	5	....	4	....	1	....	....	....	7	....
Sierra Nevada	92	6	....	....	....	....	1	....	2	....	2	3	....	....	....	....	2	....
Silver Hill	46	2	....	....	3	....	....	....	1	....	5	3	1	....	....	....	2	....
Sutro tunnel	117	3	3	....	6	....	2	....	4	....	4	2	1	....	1	1	9	....
Utah	67	2	3	....	....	....	....	....	1	....	5	3	2	....	....	....	4	....
Ward	39	1	....	....	....	....	....	....	2	....	4	2	1	....	....	....	....	....
Yellow Jacket	220	4	....	....	....	....	....	....	11	....	7	3	1	....	....	....	15	....

Mine.	Machinists.	Masons.	Mechanics.	Molders.	Millwrights.	Miners.	Molders.	Mule-drivers.	Oilers.	Painters.	Pipemen.	Porters.	Pumpmen.	Ropemen.	Shippers.	Teamsters.	Thimitis.	Watchmen.	Wood-passers.	Wood-sawyers.
Total	54	1	4	2	2	1,074	2	9	5	2	1	1	27	26	1	2	1	32	15	3
Alta	....	....	....	....	....	44	....	....	....	....	....	....	2	2	....	....	....	1	1	....
Andes	....	....	....	....	....	7	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Belcher	2	....	....	....	....	35	....	....	....	....	....	....	2	2	....	....	....	2	2	....
Best & Belcher	1	....	....	....	....	33	....	....	....	....	....	....	....	....	....	....	....	1	....	....
Bullion	....	....	....	....	....	30	....	....	....	....	....	....	....	1	....	....	....	2	....	....
Caledonia	....	....	....	....	....	12	....	....	....	....	....	....	1	....	....	....	....	1	1	....
Consolidated Imperial	3	....	....	....	....	37	....	....	....	....	....	....	....	2	....	....	....	....	....	....
Consolidated Virginia and California (C. & C. shaft)	5	....	....	2	....	277	....	....	3	....	1	1	2	3	1	....	....	5	3	2
Crown Point and Kentuck	....	....	....	....	....	22	....	....	....	....	....	....	....	....	....	....	....	1	....	....
C. N. S. shaft	....	....	....	....	....	36	....	....	....	....	....	....	4	1	....	....	....	1	....	....
Forman shaft	4	....	....	....	....	35	....	....	....	....	....	....	....	....	....	....	....	1	....	....
Gould & Curry	2	....	....	....	....	26	....	....	....	....	....	....	....	2	....	....	....	1	....	....
Hale & Norcross	3	....	....	....	....	47	....	....	....	....	....	....	....	1	....	....	....	....	....	....
Julia	1	....	....	....	....	23	....	....	....	....	....	....	2	1	....	....	....	1	....	....
Justice	....	....	....	....	....	20	....	....	....	....	....	....	....	....	....	....	....	4	....	....
Lady Bryan	....	....	....	....	....	19	....	....	....	....	....	....	1	....	....	....	....	....	....	....
Mexican and Union shaft	9	1	....	....	....	348	....	....	....	....	....	....	2	5	....	....	....	3	3	....
Mint	....	....	....	....	....	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....
New York	....	....	....	....	....	15	....	....	....	....	....	....	....	....	....	....	....	....	....	....
North Bonanza and Flowery	....	....	....	....	....	32	....	....	....	....	....	....	4	....	....	....	....	....	....	....
Ophir	3	....	....	....	....	297	....	....	1	....	....	....	3	2	....	....	....	3	4	1
Original Keystone	....	....	....	....	....	15	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Osbiston shaft	1	....	....	....	....	9	....	....	....	....	....	....	....	....	....	....	....	1	....	....
Overman	1	....	....	....	....	50	....	....	1	....	....	....	....	3	....	....	....	1	1	....
Occidental	....	....	....	....	....	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Savage	3	....	....	....	....	40	....	....	....	....	....	....	3	1	....	....	....	2	....	....
Scorpion	....	....	....	....	....	28	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Sierra Nevada	3	....	....	....	....	71	....	....	....	....	....	....	....	1	....	....	....	....	1	....
Silver Hill	1	....	....	....	....	26	....	....	....	....	....	....	1	1	....	....	....	....	....	....
Sutro tunnel	4	....	....	....	....	64	....	9	....	....	....	....	....	....	....	2	1	1	....	....
Utah	....	....	....	....	....	44	....	....	....	....	....	....	3	1	....	....	....	....	....	....
Ward	....	....	....	....	....	28	....	....	....	....	....	....	....	....	....	....	....	1	....	....
Yellow Jacket	3	....	4	....	2	161	2	....	....	2	....	....	....	....	....	....	....	....	....	....

RATE OF WAGES PAID PER SHIFT FOR DIFFERENT CLASSES OF EMPLOYÉS IN THE COMSTOCK MINES IN 1880.

Blacksmiths	$4 00 to $6 00
Blacksmiths' helpers	4 00
Brakemen	4 00 to 4 50
Car-men	4 00 to 4 50
Carpenters	5 00 to 6 50
Engineers	4 00 to 7 00
Firemen	4 00 to 4 50
Foremen	6 00 to 10 00
Laborers and surfacemen	3 50 to 4 00
Machinists	5 00 to 6 00
Miners	4 00 to 4 25
Pumpmen	4 00 to 6 00
Oilers	2 50 to 4 00
Ropemen	4 00 to 5 00
Shift bosses	5 00 to 6 00
Wood-passers and -sawyers	4 00

Table XLI and the foregoing statement are introduced by way of illustration, to show the division of labor more in detail than is practicable in tabulations covering the whole country.

SUPPLIES: THEIR CONSUMPTION AND COST.(a)

TABLE XLII.—DEEP MINES: PRICES OF MINE AND MILL SUPPLIES.

ALABAMA.

	County and district.	Wood.	Charcoal.	Coal.	Coke.
	CLEBURNE.	*Per cord.*	*Per bushel.*	*Per ton.*	*Per ton.*
1					

ARIZONA.

	MARICOPA.				
1	Globe	$4 00 to $5 00			
	MOHAVE.				
2	Cedar Valley	8 00			
3	Hualapai	8 00			
4	Owens	5 50			
	PIMA.				
5	Arivaca	5 00			
6	Tombstone	7 00 to 7 50			
	YAVAPAI.				
7	Big Bug		25 cts.		
8	Humbug	8 50			
	YUMA.				
9	Castle Dome				

CALIFORNIA.

	AMADOR.				
1	Amador City	$6 00			
2	Jackson	6 00			
3	Sutter Creek	6 00			
4	Volcano	3 50			
	CALAVERAS.				
5	Independence				
6	Mokelumne Hill				
	EL DORADO.				
7	Placerville				
8	Springfield	4 25			
	INYO.				
9	Cerro Gordo	8 50	20 cts.		
10	Coso	10 00	25 cts.		
	LASSEN.				
11	Hayden Hill				
	MARIPOSA.				
12	Hornitos	3 50			
13	Mariposa Estate				
	MONO.				
14	Bodie	10 75 to 15 00			
15	Indian	12 00			
	NEVADA.				
16	Grass Valley	4 25			
17	Nevada City	3 97 to 4 50			
	PLACER.				
18	Colfax	5 00			
	PLUMAS.				
19	Genesee Valley				
20	Indian Valley	2 00			
21	Quartz township	4 50			
22	Seneca				
	SAN BERNARDINO.				
23	Clark	9 50			
24	Dry Lake	15 00			
25	Silver Mountain	3 00			
	SAN DIEGO.				
26	Cargo Muchacho	2 00			
27	Pinecate	4 00			
	SHASTA.				
28	Pittsburg	3 50			
	SISKIYOU.				
29	Quartz Valley				
30	Sawyer's Bar	2 75	20 cts.		
31	South Fork Salmon	2 75	20 cts.	$10 00 to $15 00	
	TUOLUMNE.				
32	Confidence	2 50			
33	Jamestown	5 00			
34	Soulsbyville				

a It is evident that the information afforded by the schedules on which these tables are based is in many cases incomplete; but it was not judged best to discard such material as is here given. The variations in price depend largely upon the season at which supplies are bought and upon the amount purchased.

SUPPLIES: THEIR CONSUMPTION AND COST.

TABLE XLII.—DEEP MINES: PRICES OF MINE AND MILL SUPPLIES.

ALABAMA.

TIMBER.		Iron.	Steel.	Candles.	Nitro-glycerine powders.	Black powder.	Quicksilver.	Salt.	Bluestone.	
Board feet.	Other measure.									
Per M.		*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per ton.*	*Per pound.*	
$5 00 to $10 00				16 cts.						1

ARIZONA.

$45 00			20 cts.	17 to 25 cts.	50 to 60 cts.					1
							40 cts.	$100 00		2
				25 cts.	$1 00		70 cts.	80 00		3
		10 cts.	30 cts.				50 cts.	80 00	15 cts.	4
30 00 to 35 00			22 cts.	20 to 27½ cts.	70 cts.		42 cts.	60 00	9 cts.	5
							45 cts.		12½ cts.	6
			20 cts.	19 cts.	54 cts.					7
			25 cts.	20 cts.	40 to 75 cts.	50 cts.				8

CALIFORNIA.

$23 50		5 cts.	16 cts.	14 cts.	30 cts.		50 cts.			1
30 00										
		10 cts.			30 cts.		45 cts.			2
30 00				20 cts.	40 cts.					3
										4
							35 cts.			5
							40 cts.			6
30 00		6 cts.	18 cts.		35 cts.		50 cts.			7
							50 cts.			8
	15 cts. per running foot									9
										10
10 00 to 15 00		9 cts.	25 cts.	25 cts.	75 cts.	20 cts.	40 to 50 cts.			11
							40 cts.			12
30 00		2½ to 6½ cts.	18 cts.		40 cts.		38 cts.	$50 00	15 cts.	13
42 00 to 50 00		8 to 10 cts.	14 cts.	16 to 22 cts.	36 to 38 cts.		50 cts.	35 00 to 50 00		14
										15
							40 cts.			16
16 00	Round, 15 cts				32 to 33 cts.		40 cts.	7 50		17
16 00 to 18 00					30 cts.					18
	11½ cts. per running foot		18 cts.	17½ cts.	56 cts.					19
20 00 to 30 00		7 cts.	20 cts.	17½ cts.	30 to 75 cts.		60 cts.			20
90 00		6.15 to 6.9 cts.	7½ to 15 cts.	19½ cts.	37 cts.	5½ cts.	40 cts.			21
20 00		7 cts.	23 cts.	20 cts.	50 cts.	22½ cts.	50 cts.			22
	30 to 50 cts. per piece	5½ to 15 cts.	21 to 23 cts.	20 to 22½ cts.		20 cts.	45 to 50 cts.	30 00	16 cts.	23
45 00										24
35 00										25
							40 cts.			26
24 00										27
							45 cts.	22 00		28
15 00		6½ cts.		22½ cts.		19 cts.	30 cts.			29
50 00 to 55 00		9 to 10 cts.	20 cts.	25 cts.	30 cts.	18 cts.	40 cts.			30
20 70 to 35 00		4 to 5½ cts.	19 cts.	20½ cts.	46.8 cts.	20 cts.	42 cts.			31
12 00				18 cts.	40 cts.					32
20 00										33
15 00		5 cts.	17 cts.	17 cts.	55 cts.					34

TABLE XLII.—DEEP MINES: PRICES OF MINE AND MILL SUPPLIES.

COLORADO.

	County and district.	Wood.	Charcoal.	Coal.	Coke.
	ARAPAHOE.	*Per cord.*	*Per bushel.*	*Per ton.*	*Per ton.*
1	Argo	$6 00		$4 50	
	BOULDER.				
2	Central	3 00 to 3 25	18 cts.		
3	Gold Hill	3 00 to 3 50			
4	Grand Island	2 00 to 3 50	18 to 20 cts.	25 00	
5	Magnolia	3 00			
6	Sugar-loaf				
7	Ward	2 50			
8				a 2 50	$15 00
	CHAFFEE.				
9	Chalk Creek				
10	Monarch				
	CLEAR CREEK.				
11	Argentine	5 00	18 cts.		
12	Banner				
13	Cascade				
14	Griffith	4 50 to 12 50	20 cts.		
15	Idaho				
16	Iowa				
17	Montana				
18	Morris				
19	Mountain				
20	Seaton				
21	Spanish Bar				
22	Trail Run				
23	Upper Union	3 00			
24	Virginia	4 00			
	CUSTER.				
25	Hardscrabble	4 25 to 5 00			
26	Verde	3 00		24 00	
27		3 00		18 00	
	GILPIN.				
28	Enterprise	5 00 to 6 00			
29	Enterprise and Mountain House				
30	Eureka	5 50 to 6 00			
31	Gregory	5 50 to 7 00		5 00 to 12 00	
32	Hawkeye				
33	Mountain House				
34	Nevada	5 50 to 7 00		5 75 to 7 00	
35	Quartz Valley			7 25	
36	Russell	6 00 to 7 00		7 00	
	GUNNISON.				
37	Tin Cup				
	HINSDALE.				
38	Galena	4 00	15 cts.		
39	Lake		15 cts.		
40	Park		28 cts.		
	HUERFANO.				
41	Third	3 00		10 00	
	JEFFERSON.				
42	Golden City			3 50 to 6 50	17 80
	LAKE.				
43	California	5 50 to 7 00	10 to 18 cts.		25 00 to 60 00
	OURAY.				
44	Iron Springs		25 cts.		
45	Pioneer		12 cts.		
46	Sneffles		20 cts.		
47	Uncompahgre	3 25	18 to 25 cts.		
48	Upper San Miguel		20 to 50 cts.	21 00	
	PARK.				
49	Buckskin	8 00	15 cts.		
50	Consolidated Montgomery	8 00			
51	Horseshoe				
52	Mosquito	8 00 to 35 00			38 50
53	Sacramento		15 cts.		
	PUEBLO.				
54	Pueblo			1 75	7 50
	RIO GRANDE.				
55	Summit	2 50	20 cts.		
	SAN JUAN.				
56	Animas	5 00	12 to 25 cts.		
57	Eureka	5 00	25 cts.		
58	Uncompahgre		20 to 28 cts.		

a Lignite.

TABLE XLII.—DEEP MINES: PRICES OF MINE AND MILL SUPPLIES.

COLORADO.

TIMBER.		Iron.	Steel.	Candles.	Nitro-glycerine powders.	Black powder.	Quicksilver.	Salt.	Bluestone.	
Board feet.	Other measure.									
Per M.		*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per ton.*	*Per pound.*	
										1
$18 00		3 to 5½ cts.	17 cts.	16½ cts.		19 cts.	75 cts.			2
18 00		4 cts.	16 cts.		40 cts.		75 cts.			3
16 00 to 20 00		3 to 7 cts.	18 to 21 cts.	17½ to 40 cts.	38 to 40 cts.		75 cts.	$27 00		4
					40 cts.					5
18 00			18 cts.	16 cts.	40 cts.					6
							75 cts.			7
										8
		6½ cts.	20 cts.							9
			30 cts.							10
27 00		7½ cts.	22 cts.	16½ cts.	40 cts.	18½ cts.				11
20 00		5½ cts.	20 cts.	15 cts.	40 cts.	16 cts.				12
			22 cts.	20 cts.	18 cts.					13
20 00 to 50 00		5 to 6 cts.	20 cts.	14½ to 20 cts.	40 cts.	18½ cts.	45 cts.	24 00		14
10 00 to 25 00		6 cts.	22 cts.	15 to 20 cts.	40 cts.	14 to 16 cts.	50 cts.			15
10 00			20 cts.	20 cts.	40 cts.					16
15 00		4½ cts.	22 cts.	16 cts.	40 cts.					17
20 00 to 22 00		6 to 7 cts.	20 to 23 cts.	15 to 17 cts.	40 cts.	19 cts.	65 cts.			18
20 00		8 cts.	21 cts.	15 cts.	40 cts.					19
10 00		4½ cts.	14 cts.	14 cts.	36 cts.	15½ cts.				20
			20 to 22 cts.	15 cts.	40 cts.					21
15 00 to 25 00		4½ cts.	22 cts.	16 cts.	40 cts.	16 cts.				22
	5 cents per running foot	8 cts.	25 cts.	15 cts.			50 cts.			23
10 00		5 cts.	22 cts.	16 cts.		15 cts.				24
17 00 to 25 00		8½ to 14 cts.	20 to 22 cts.	14 to 17½ cts.	30 to 45 cts.	15 to 15½ cts.	55 cts.	47 50	15½ cts.	25
20 00		6½ cts.	22 cts.	17½ cts.	40 cts.					26
10 00 to 35 00						16 cts.				27
		5 cts.	11 to 14 cts.				50 cts.			28
7 50		5 cts.	18 cts.	17 to 17½ cts.	40 cts.	15 cts.				29
20 00		5 cts.		15 cts.			50 cts.			30
20 00 to 25 00		4½ to 5 cts.	12 to 22½ cts.	15 cts.	40 cts.	16 cts.	50 to 51 cts.			31
25 00		5 cts.	16½ cts.	15 cts.	40 cts.	14 cts.				32
28 00			17 cts.	16 cts.						33
12 50 to 35 00		5 to 5½ cts.	12 to 21 cts.	15 to 17 cts.	40 cts.	14 to 16½ cts.	45 to 50 cts.			34
20 00		5 cts.	22 cts.	15 cts.	40 cts.	15 cts.				35
20 00 to 35 00		4½ cts.	16½ to 21 cts.	15 to 20 cts.	40 cts.					36
30 00		8 cts.	25 cts.	18 cts.	50 cts.	18 cts.				37
20 00		15 cts.	26 cts.	25 cts.	50 cts.	20 cts.				38
			28 cts.	25 cts.	50 cts.	20 cts.				39
75 00		18 cts.	27 cts.	27 cts.	45 cts.	20 cts.				40
50 00		8 cts.	25 cts.			18 cts.				41
										42
10 40		10½ to 11 cts.	17½ to 21½ cts.	16½ to 17½ cts.	42½ to 45 cts.	21½ cts.				43
7 00 to 17 00			25 to 30 cts.	22 to 30 cts.	26 to 35 cts.	20 to 25 cts.				44
10 00			22 cts.	17½ cts.		28 cts.				45
3 75			25 cts.	22½ cts.	50 cts.	20 cts.				46
5 00 to 10 00		12 cts.	21½ to 35 cts.	24½ to 30 cts.	50 to 65 cts.	21 to 25 cts.				47
5 00 to 40 00			25 to 40 cts.	22½ to 30 cts.	26 cts. to $1 00	11 to 30 cts.				48
25 00			22 cts.	18 cts.	50 cts.					49
50 00	$7 50 per cord	12½ cts.	22 cts.	17 cts.	50 cts.	16 to 17 cts.				50
		12 cts.	22 cts.	18 cts.	50 cts.					51
			22 to 25 cts.	18 to 18½ cts.	50 cts.	16 to 18 cts.				52
		5 cts.	20 cts.	15 cts.	40 cts.	15 cts.				53
										54
		8 to 9 cts.	35 cts.	20 cts.		20 cts.	60 cts.			55
6 00 to 30 00		16 to 17 cts.	16 to 26 cts.	20 to 25 cts.	45 cts. to $1 00	20 to 25 cts.				56
11 00 to 25 00		16 to 17 cts.	23 to 30 cts.	22½ to 35 cts.	40 to 55 cts.	20 to 22 cts.				57
11 00 to 30 00		10 cts.	24 to 30 cts.	23 to 34 cts.	50 cts.	23 cts.				58

TABLE XLII.—DEEP MINES: PRICES OF MINE AND MILL SUPPLIES.

COLORADO—Continued.

	County and district.	Wood.	Charcoal.	Coal.	Coke.
	SUMMIT.	*Per cord.*	*Per bushel.*	*Per ton.*	*Per ton.*
59	Avalanche	$3 00 to $4 00	12½ cts.		
60	Bevan				
61	Consolidated Ten-mile	3 00			
62					
	DAKOTA.				
	CUSTER.				
1	Cole				
2	Custer				
3	Whitewood	$3 50			
	LAWRENCE.				
4	Bear Butte	2 50 to 4 00			
5	Lost Placer	5 00			
6	Whitewood	3 00 to 5 50			
	PENNINGTON.				
7	Cross				
8	Newton Forks				
9	Rockford				
	GEORGIA.				
	CHEROKEE.				
1	Hickory Flat				
2	Third and Second	75 cts.			
	FORSYTH.				
3	Third and First	90 cts.			
	HALL.				
4	Ninth				
	LINCOLN.				
5		50 to 80 cts.			
	M'DUFFIE.				
6	Republican	80 cts.			
	MERIWETHER.				
7		90 cts.			
	IDAHO.				
	ALTURAS.				
1	Bonaparte		22 cts.		
2	Middle Boisé	$3 50	25 to 30 cts.		
3	Queen's River	3 00	20 cts.		
4	Rocky Bar, or Bear Creek		25 cts.		
	BOISÉ.				
5	Banner	3 50	20 cts.		
6	Cañon Creek		25 cts.		
7	Granite	3 80	20 cts.		
8	Shaw's Mountain		12 to 20 cts.		
	LEMHI.				
9	Bay Horse		18 cts.		
10	Yankee Fork		20 cts.		
	OWYHEE.				
11	Carson	6 50 to 7 50	25 to 35 cts.		
12	Wagontown	4 50 to 5 00	25 to 40 cts.		
	MAINE.				
	HANCOCK.				
1	Sullivan			$4 00	
	PENOBSCOT.				
2	Carmel				
3				6 00	
	WASHINGTON.				
4	Fifth				

TABLE XLII.—DEEP MINES: PRICES OF MINE AND MILL SUPPLIES.

COLORADO—Continued.

TIMBER.		Iron.	Steel.	Candles.	Nitro-glycerine powders.	Black powder.	Quicksilver.	Salt.	Bluestone.	
Board feet.	Other measure.									
Per M.		*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per ton.*	*Per pound.*	
$30 00			25 cts.	17½ cts.			47 cts.			59
	30 cts. per piece	5 cts.	14 cts.	15 cts.	47½ cts.					60
			24 cts.			20.8 cts.				61
										62

DAKOTA.

$20 00			25 cts.	20 to 30 cts.	50 cts.	17 to 18 cts.				1
2 00 to 20 00			22 to 25 cts.	18 to 30 cts.	50 to 60 cts.	18 to 20 cts.				2
17 00		8 cts.	20 cts.	18 cts.	45 cts.					3
10 00 to 25 00		8 to 10 cts.	22 to 30 cts.	18 to 30 cts.	45 to 50 cts.	14 to 18 cts.	45 cts.	$80 00		4
19 50 to 20 00		7 to 8 cts.	20 cts.	18 cts.	45 cts.	14 cts.	60 cts.			5
10 00 to 75 00		7 to 11 cts.	12½ to 28 cts.	18 to 26 cts.	45 cts.	14 to 15 cts.	45 to 65 cts.			6
			28 cts.	30 cts.	50 cts.	19 cts.				7
10 00 to 25 00			25 to 30 cts.	30 cts.	50 to 60 cts.	20 to 25 cts.				8
20 00 to 25 00		8 cts.	22 to 25 cts.	15 to 18 cts.	45 to 48 cts.	16 cts.				9

GEORGIA.

$10 00		3 cts.	17 cts.	12 cts.						1
		3 cts.	20 cts.	15 cts.						2
	50 cts. per cord	3 cts.	45 cts.	15 cts.	25 cts.	18 cts.				3
				20 cts.		18 cts.				4
10 00 to 12 50		3½ to 4 cts.	16 cts.	15 to 16 cts.		13½ cts.				5
10 00		3 cts.	20 cts.	16 cts.		15 cts.				6
	$2 per cord		18 cts.	14 cts.	50 cts.					7

IDAHO.

	2 cts. per running foot	10 cts.	28 cts.	23 cts.	70 to 80 cts.					1
	$2 50 to $4 per set	12½ to 15 cts.	17 to 35 cts.	24 to 25 cts.	46 to 85 cts.		60 cts.	$97 50	18 cts.	2
	$2 50 per set		21 to 23 cts.	25 cts.	50 to 75 cts.					3
		12½ cts.	25 cts.	20 cts.	80 cts.		60 cts.			4
	2½ cts. per running foot	12 to 15 cts.	25 cts.	20 cts.	65 to 80 cts.		55 cts.	90 00	18 cts.	5
	do									6
		10 cts.	20 cts.	20 cts.	60 cts.		45 cts.			7
			25 cts.	25 cts.	80 to 90 cts.		50 cts.			8
			27 cts.	25 cts.	50 to 75 cts.	23 cts.				9
			27½ cts.	27 cts.	64 cts.					10
$50 00 to $100 00		9 to 15 cts.	20 to 35 cts.	20 to 25 cts.	50 to 90 cts.		48 cts.	80 00	12½ cts.	11
90 00		12½ to 13 cts.	25 to 30 cts.	25 to 27½ cts.	75 to 90 cts.		55 cts.	80 00	25 cts.	12

MAINE.

					45 cts.					1
$12 00			13 cts.		45 cts.					2
12 50		4½ cts.	14½ cts.		45 cts.					3
					48 cts.					4

TABLE XLII.—DEEP MINES: PRICES OF MINE AND MILL SUPPLIES.

MONTANA.

	County and district.	Wood.	Charcoal.	Coal.	Coke.
		Per cord.	*Per bushel.*	*Per ton.*	*Per ton.*
	BEAVER HEAD.				
1	Bald Mountain	$2 00			
2	Bannock	4 75			
3	Trapper				
4					
	DEER LODGE.				
5	Flint Creek	3 75 to 4 50			
6	Silver Creek	2 80 to 2 90			
7	Summit	4 50			
8	Summit Valley	3 50 to 5 00	16 cts.		
	JEFFERSON.				
9	Cedar Plains	6 00			
10	Colorado	4 00	15 cts.		
11	Elkhorn	2 50			
12	Mountain				
13		3 00			
	LEWIS AND CLARKE.				
14	Owyhee	5 00			
15	Silver Creek	3 25			
16	Stemple	2 50 to 3 00			
	MADISON.				
17	Hot Spring	8 50			
18	Lower Hot Spring				
19	Mineral Hill				
20	Silver Star				

NEVADA.

	ELKO.				
1	Columbia	$6 00	45 cts.		
2	Tuscarora	*a* 11 00	45 cts.		
	ESMERALDA.				
3	Columbus	18 00 to 20 00	40 cts.		
4	Esmeralda	8 00			
5	Oneota	5 00			
6	Wilson	7 00			
	EUREKA.				
7	Cortez	6 00	25 cts.		
8	Eureka	9 00 to 11 00	25 to 30 cts.		
9	Secret Cañon	4 50	15 cts.		
	HUMBOLDT.				
10	Mount Rose		35 to 50 cts.	$12 00	
11	Sierra, or Dun Glen				
	LANDER.				
12	Lewis	12 00			
13	Reese River	12 00	30 cts.		
	LINCOLN.				
14	Ely	6 00			
	NYE.				
15	Tybo	6 00			
16	Union	3 50			
	STOREY AND LYON.				
17	The Comstock	9 50 to 12 50	40 cts.		
	WHITE PINE.				
18	Cherry Creek	5 75 to 6 50			
19	Ward	5 30			
20	White Pine	7 50	25 cts.	8 50	

a Sagebrush, $2 40 to $2 50.

NEW MEXICO.

	GRANT.				
1	Chloride Flat	$2 50			
2	Lone Mountain				
3	Pinos Altos				
4	Silver Flat	2 50			

NORTH CAROLINA.

	DAVIDSON.				
1	Emmons township	$0 30			
2		0 40			
	GASTON.				
3		1 25			

TABLE XLII.—DEEP MINES: PRICES OF MINE AND MILL SUPPLIES.

MONTANA.

TIMBER.		Iron.	Steel.	Candles.	Nitro-glycerine powders.	Black powder.	Quicksilver.	Salt.	Bluestone.	
Board feet.	Other measure.									
Per M.		*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per ton.*	*Per pound.*	
		22 cts.					80 cts.	$90 00	12 cts.	1
							90 cts.			2
										3
		20 cts.					55 cts.	70 00	20 cts.	4
$12 00 to $28 00		2 to 20 cts.	22 to 30 cts.	18 to 25 cts.	52 to 75 cts.	20 cts.	50 cts.	70 00 to 75 00	10 cts.	5
		9 to 10 cts.	18 cts.	21½ cts.	50 to 75 cts.	20 to 23½ cts.	50 cts.			6
				20 cts.	90 cts.	20 cts.				7
12 00 to 25 00		6½ to 20 cts.	15 to 25 cts.	18 to 22 cts.	60 to 90 cts.	16 to 20 cts.	45 to 50 cts.	45 00 to 50 00	8½ to 15 cts.	8
2 00		9 cts.	17 cts.	15 cts.	75 cts.	18 cts.				9
										10
							50 cts.	60 00	12½ cts.	11
18 00		7 cts.	23 to 25 cts.	20 to 21½ cts.	55 cts.	19 cts.				12
		8 cts.	23 cts.	12½ cts.			60 cts.			13
		25 cts.		20 cts.		18 cts.				14
		7 to 8½ cts.	17½ cts.	20½ cts.	50 cts.	18½ cts.	45 cts.	90 00		15
40 00		10 to 12 cts.	20 to 25 cts.	23 to 25 cts.	55 to 90 cts.	20 to 25 cts.	50 to 60 cts.			16
27 50		10 cts.	35 cts.	25 cts.			65 cts.			17
				21½ cts.		18 cts.				18
			22 cts.	25 cts.		20 cts.				19
		10 cts.	22 to 25 cts.	25 cts.	60 to 90 cts.	17 to 18 cts.				20

NEVADA.

	8 cts. per running foot	9 cts.	25 cts.	16½ cts.	28 cts.		50 cts.	$40 00		1
$50 00	16 to 20 cts. per running foot	8½ to 17 cts.	22 to 30 cts.	20 to 25 cts.	45 to 80 cts.		45 cts.	35 00	15 cts.	2
50 00			19 to 20 cts.	40 cts.			43 cts.	16 00		3
								35 00		4
								30 00		5
										6
60 00	$1 per running foot	9 cts.	23 cts.	21 cts.	37½ cts.		50 cts.	30 00		7
46 00 to 55 00		8 to 10 cts.	20 to 22 cts.	21½ to 25 cts.	50 to 56 cts.	13⅓ to 22½ cts.				8
			22 cts.							9
		8 to 12 cts.	25 cts.	20 cts.	60 cts.		50 cts.	40 00	15 cts.	10
			19 cts.	14 cts.						11
			23 cts.	20 cts.						12
							45 cts.	30 00		13
	55 cts. per running foot	10 cts.	24 cts.	22½ cts.	85 cts.	20 cts.				14
		12 cts.					50 cts.	60 00		15
				22½ cts.	74 cts.		45 cts.	35 00		16
17 50 to 25 00		5½ to 8 cts.	12 to 21 cts.	18 to 20 cts.	35 to 55 cts.		40 to 45 cts.	20 00	10 cts.	17
40 00		6 to 8 cts.	18 cts.	21 cts.	45 to 80 cts.	18 cts.	45 cts.	30 00	9 cts.	18
		10 cts.		20 cts.	80 cts.		50 cts.	35 00		19
75 00			22 to 25 cts.	20 to 24 cts.	58 cts.		50 cts.	35 00		20

NEW MEXICO.

$45 00		5 cts.	25 to 28 cts.	20 cts.		18 to 20 cts.				1
45 00		5 cts.	22½ cts.	20 cts.		18 cts.				2
40 00		5 to 6 cts.	25 cts.	22 cts.		20 cts.				3
45 00 to 50 00		2½ to 5 cts.	25 cts.	20 cts.	45 cts.	20 cts.	54 cts.	$50 00	14½ cts.	4

NORTH CAROLINA.

$7 50				14 cts.		15 cts.				1
10 00		4½ cts.	16 cts.							2
		5 cts.	18 cts.	13 cts.	50 cts.	15 cts.				3

TABLE XLII.—DEEP MINES: PRICES OF MINE AND MILL SUPPLIES.

NORTH CAROLINA—Continued.

	County and district.	Wood.	Charcoal.	Coal.	Coke.
	GUILFORD.	*Per cord.*	*Per bushel.*	*Per ton.*	*Per ton.*
4					
	MECKLENBURG.				
5	Capp's Hill	$1 00			
6	Sixth	1 75			
7		1 60			
	MOORE.				
8					
	ROWAN.				
9		0 70			

OREGON.

	BAKER.				
1	Burnt River				
2	Connor Creek	$6 00			
3	Pocahontas				
4	Rye Valley	3 00 to 3 50			
5	Silver Creek				
6		5 00			

UTAH.

	BEAVER.				
1	San Francisco	$2 50	17 to 18 cts.		
	SALT LAKE.				
2	West Mountain	6 00 to 8 00	10 to 12½ cts.	$7 00 to $15 00	$20 00 to $23 00
	SUMMIT.				
3	Uinta	3 25 to 4 00		3 25 to 10 75	
	TOOELE.				
4	Ophir				
5	Rush Valley	4 00		$9 50	
	UTAH.				
6	American Fork				
	WABATCH.				
7	Snake Creek				
	WASHINGTON.				
8	Harrisburg, or Silver Reef	7 00 to 8 00		15 00	

VIRGINIA.

	CULPEPER.				
1		$1 00		$6 00	
	LOUISA.				
2	Cochoo	1 50			

TABLE XLII.—DEEP MINES: PRICES OF MINE AND MILL SUPPLIES.

NORTH CAROLINA—Continued.

TIMBER.		Iron.	Steel.	Candles.	Nitro-glycerine powders.	Black powder.	Quicksilver.	Salt.	Blnestone.	
Board feet.	Other measure.									
Per M.		*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per pound.*	*Per ton.*	*Per pound.*	
$7 50										4
10 00		5 cts.	16 cts.	16 cts.	45 cts.					5
10 00		3 cts.	17 cts.	13 cts.	45 cts.					6
		a $\frac{7}{10}$ cts.					45 cts.			7
10 00		2 cts.	18 cts.	16 cts.	45 cts.					8
40 00		3½ cts.	18 cts.	16½ cts.	50 cts.					9

a Scrap iron.

OREGON.

$25 00		11 to 12½ cts.	25 cts.	20 cts.	$1 00		$1 00			1
9 40		14 cts.	22 cts.	26 cts.	70 cts.		68 cts.			2
25 00			25 cts.	25 cts.	85 cts.	50 cts.				3
11 00		25 cts.	17 cts.	25 cts.	1 00		60 cts.		15 cts.	4
		15 cts.	20 cts.	10 cts.	90 cts.					5
20 00		12½ cts.	20 cts.	12 cts.	75 cts.		75 cts.			6

UTAH.

										1
				8½ cts.						2
$27 50 to $50 00			20 cts.		85 cts.			$8 00		3
				20 cts.		12½ cts.				4
30 00		9 cts.	20 cts.	16½ cts.		14½ cts.				5
	7 cts. per running foot									6
				20 cts.	85 cts.					7
45 00	15 to 18 cts. per running foot		24 to 25 cts.	21½ to 23½ cts.	85 cts.	18 to 19 cts.	45 cts.	$30·00	15 to 17 cts.	8

VIRGINIA.

				10 cts.	27½ cts.	15 cts.				1
$12 00		3 cts.	12½ cts.		40 cts.					2

It needs but a moment's consideration to perceive how important an influence the prices of supplies have upon the mining industries, and how they enter into all discussions of the methods employed. Processes which yield a fair profit in localities where labor and supplies are to be had at low rates would result in a loss in a great portion of the mining districts of the far West, and processes and methods developed in other regions must be modified to suit the local economical conditions or be abandoned. The higher cost of mine supplies in the mining camps of the West, as compared with the prices demanded for the same articles at centers like San Francisco, Saint Louis, or Chicago, is almost entirely due to expense of transportation. This often exceeds the original cost of the article transported, and sometimes reverses the relative value of materials in their technical application. Steel may be worth four times as much as iron at commercial centers; but as the freight on each metal is the same, steel at a mining camp may be worth but twice as much as iron. If, for a given purpose, steel will do three times as much service as iron, the latter will be employed at centers of commerce, while the former will be more economical in the mining regions. The application of these relations to the choice of boilers has already been pointed out, and many instances will occur to the professional reader in which they would govern the choice of material, apparatus, and process.

As has been mentioned, the price of articles of uniform quality, such as candles and quicksilver, is a gauge of the rates of transportation and an index of the cost of supplies excepting such as the locality itself may supply. Salt is naturally cheap near the Great Salt lake and other deposits, while at long distances from them it is extremely expensive. At the Uintah district, Utah, salt is worth $8 per ton, but in some districts in Arizona it sells for $100. It might clearly be more economical to amalgamate raw an ore in Arizona containing a considerable proportion of rebellious silver minerals, which it would be folly not to roast if it were found at the Uintah district. Similarly it will make a great difference in the system of timbering a mine whether timber is worth $6 or $100 per thousand feet.

TABLE XLIII.—DEEP MINES: ITEMIZED COST OF SUPPLIES.

State or territory and county.	No. of mines reported.	Coal.	Charcoal.	Wood.	Timber.	Iron.	Steel.	Candles.	Explosives.	Sundries.
ALABAMA.										
Cleburne	1				$78 00			$64 00		
Talladega	1									$50 00
ARIZONA.										
Maricopa	2									8,476 00
Mohave	1							20 00	$100 00	
Pima	14			$3,303 00	3,690 00		$50 00	120 00	1,200 00	25,113 00
Pinal	3									4,489 00
Yuma	1				429 00					1,330 00
CALIFORNIA.										
Amador	4			29,646 00	31,930 50	$6,050 00	5,092 00	3,091 00	5,790 00	4,860 00
El Dorado	2			6,587 50	280 00	43 20	216 00	780 00	780 00	
Inyo	6			4,250 00						24,575 56
Lassen	3									11,404 00
Mariposa	1				2,400 00	90 00	78 00	67 50	1,920 00	
Mono	18			131,607 00	26,261 00	1,120 00	877 00	5,583 00	10,044 00	4,085 43
Nevada	5			4,700 00	716 00	110 00	75 00	620 00	10,031 20	
Placer	1				170 00				1,200 00	
Plumas	6			3,064 50	9,328 63	2,905 85	1,963 63	5,030 72	11,587 61	321 00
San Bernardino	2				1,505 00	170 00	335 00	1,095 00	1,350 00	
Siskiyou	3	$651 00	$1,500 00	3,011 25	6,838 20	1,422 94	621 32	2,332 25	4,281 00	3,042 45
Tuolumne	2			1,250 00	725 00	150 00	170 00	580 00	1,900 00	
COLORADO.										
Boulder	10	200 00	1,164 00	13,535 00	6,930 00	1,043 70	1,957 70	6,972 00	9,989 00	360 00
Chaffee	2					78 00	35 00	141 00	3 70	
Clear Creek	31		654 18	1,543 20	4,969 50	6,766 53	2,036 60	6,111 20	14,556 15	19,382 42
Custer	7	408 00		6,018 00	11,123 00	3,204 50	1,308 00	2,212 00	3,546 00	504 00
Gilpin	25	3,910 00		57,168 50	12,267 22	3,180 00	1,989 12	7,813 57	10,308 17	846 45
Gunnison	1				750 00	240 00	125 00	72 00	182 50	
Hinsdale	3		117 00		425 00	150 00	414 60	328 50	635 00	
Huerfano	1	60 00		30 00	50 00	230 00	125 00		245 00	
Lake	21		420 00	28,855 00	90,829 14	6,253 19	2,236 99	13,083 90	11,083 19	190,563 76
Ouray	16	42 00	355 55		2,018 33	204 00	574 10	606 00	2,586 65	
Park	9		37 50	2,824 00	361 25	217 77	596 22	1,177 20	3,434 80	1,000 00
Rio Grande	1		14 00			27 00	175 00	8 00	50 00	
San Juan	18		2,231 00	9,000 00	1,293 08	1,215 00	2,492 45	3,604 13	9,551 11	
Summit	4			4,000 00	210 00	450 00	930 50	2,058 00	2,524 00	
DAKOTA.										
Custer	9			315 00	688 50	1,684 00	158 85	118 80	1,433 85	
Lawrence	41			431 75	30,281 45	8,133 71	4,436 49	7,822 20	40,599 85	150,782 00
Pennington	7				510 00	80 00	239 70	153 00	1,877 50	
GEORGIA.										
Cherokee	2			90 00	50 00	9 00	11 50	112 80		
Cobb	1									200 00
Forsyth	1			985 50	50 00	15 00	22 50	108 00	39 30	
Hall	2					60 00	100 00	80 00	15 75	400 00
Lincoln	3			692 70	280 81	8 50	8 00	83 80	54 45	
McDuffie	1			361 60	40 00	15 00	40 00	144 60	60 00	
Meriwether	1			382 85	100 00		18 00	39 62	25 00	
IDAHO.										
Alturas	12		854 50	2,328 50	4,612 50	1,634 00	491 71	1,633 00	4,149 50	300 00
Boisé	6		575 50	6,650 00	4,310 00	50 00	378 75	1,528 00	3,021 00	2,725 00
Lemhi	2		320 00		1,250 00		82 00	552 40	1,767 00	
Owyhee	8		1,005 75	4,850 00	2,698 00	211 80	309 75	896 40	3,721 00	1,277 50

TABLE XLIII.—DEEP MINES: ITEMIZED COST OF SUPPLIES—Continued.

State or territory and county.	No. of mines reported.	Coal.	Charcoal.	Wood.	Timber.	Iron.	Steel.	Candles.	Explosives.	Sundries.
MAINE.										
Hancock	1	$300 00							$1,800 00	
Penobscot	2	900 00			$420 00	$382 50	$127 50		1,012 50	
Washington	1								690 00	
MONTANA.										
Beaver Head	8			$4,750 00						$1,555 00
Deer Lodge	24			42,615 00	23,161 10	2,454 30	7,692 20	$16,305 50	19,002 70	
Jefferson	4			936 00	478 00	177 80	112 95	306 50	311 50	
Lewis and Clarke	5		$648 00	1,100 00	200 00	283 00	521 50	1,200 50	3,082 45	
Madison	5				545 50	10 00	183 80	457 00	753 75	
NEVADA.										
Elko	11		1,791 00	74,203 50	18,219 72	1,149 13	803 00	5,346 75	13,741 50	437 50
Esmeralda	10			5,280 00	4,000 00	868 20			1,584 00	46,510 58
Eureka	18		974 10	27,279 00	13,345 19	2,977 42	2,385 10	7,893 73	15,749 67	110,086 61
Humboldt	2	24 00	300 00		240 00	133 00	65 00	306 00	1,200 00	150 00
Lander	1			6,564 00			132 00	960 00	1,128 00	
Lincoln	1			43,200 00	3,025 00	2,500 00	1,440 00	4,320 00	4,060 00	
Nye	3				6,000 00			1,080 00	7,992 00	
Storey and Lyon	32			1,100,000 00	500,000 00	52,435 14	22,003 92	123,265 64	208,127 60	12,840 00
White Pine	4		18 75	87,747 00	8,474 09	2,854 50	1,044 50	2,517 00	22,335 50	200,000 00
NEW MEXICO.										2,540 58
Grant	10			117 50	1,742 12	53 95	925 75	1,187 80	2,741 10	
Santa Fé	1					1 25	35 00	32 00	50 00	25 00
NORTH CAROLINA.										
Davidson	4			1,590 40	5,350 00	630 00	556 00	672 00	975 00	826 00
Gaston	1			1,125 00		25 00	240 00	780 00	487 50	
Guilford	1				240 00			1 45		
Mecklenburg	2			2,709 00	530 00	77 00	128 00	313 00	551 25	
Moore	1			336 00	200 00	4 00	180 00	48 00	135 00	
Nash	1									600 00
Rowan	1			1,330 00	200 00	17 50	90 00	604 80	140 00	
Stanley	1									200 00
OREGON.										
Baker	6		240 00	25,900 00	4,014 76	724 00	880 00	1,010 20	3,725 30	
Grant	2				540 00	160 00	256 00	846 00	1,385 00	
Josephine	1					4 00	15 00	52 50	75 00	
UTAH.										
Beaver	11									55,405 78
Juab	7				1,200 00					13,214 00
Pi Ute	2									2,600 00
Salt Lake	41	2,000 00		4,000 00	830 00	200 00	150 00	1,402 00	2,692 00	121,613 92
Summit	6	7,685 50		42,460 50	1,602 23	2,803 64		3,144 00	5,178 80	23,338 99
Tooele	12	342 25		1,000 00	499 17	519 93	150 20	665 50	253 30	14,582 22
Utah	6				1,500 00					4,725 00
Wasatch	7				350 00	150 00		400 00	255 00	15,724 50
Washington	7	908 01	173 80	522 25	1,565 86	112 85	495 05	2,497 71	4,693 23	10,105 95
VIRGINIA.										
Buckingham	1									700 00
Culpeper	1	6 00		70 00			10 00	88 00	190 05	
Fauquier	1									2,000 00
Louisa	1			487 50	180 00	30 00	46 50		60 00	90 00
Stafford	1									600 00
WASHINGTON.										
Yakima	1									500 00

TABLE XLIV.—DEEP MINES: ITEMIZED COST OF SUPPLIES.

RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	No. of mines reported.	Coal.	Charcoal.	Wood.	Timber.	Iron.	Steel.	Candles.	Explosives.	Sundries.
Total	589	$17,307 66	$13,400 63	$1,752,206 50	$859,172 55	$116,376 80	$71,718 45	$248,485 81	$502,792 98	$1,007,719 18
Alabama	2				78 00			64 00		50 00
Arizona	21			3,303 00	4,119 00		50 00	140 00	1,300 00	39,408 00
California	53	651 90	1,500 00	184,116 25	86,154 33	12,067 90	10,067 95	19,239 47	49,783 81	48,868 44
Colorado	149	4,620 00	4,993 23	122,973 70	131,327 22	23,309 69	15,076 28	44,365 50	68,695 27	212,656 63
Dakota	57			746 75	31,449 95	9,877 71	4,835 04	7,794 00	43,402 20	150,762 00
Georgia	10			2,512 65	520 81	107 50	200 00	568 85	194 50	700 00
Idaho	28		2,761 75	13,328 50	12,870 50	1,295 80	1,462 21	4,609 80	12,658 50	4,302 50
Maine	4	1,200 00			420 00	382 50	127 50		3,502 50	
Montana	46		648 00	49,401 00	24,364 00	2,905 10	7,850 45	12,369 50	23,750 40	1,555 00
Nevada	82	24 00	3,083 85	1,294,273 50	553,304 00	62,917 39	27,873 52	145,689 12	275,918 27	372,565 26
New Mexico	11			117 50	1,742 12	55 20	960 75	1,219 80	2,791 10	25 00
North Carolina	12			7,690 40	6,520 00	758 50	1,192 00	2,419 85	2,288 75	1,626 00
Oregon	9		240 00	25,900 00	4,554 76	886 00	1,151 00	1,906 70	5,185 30	
Utah	90	10,896 76	173 80	47,863 75	7,547 26	3,786 42	795 25	8,109 21	13,072 23	261,310 36
Virginia	5	6 00		557 50	180 00	30 00	56 50	88 00	250 05	3,390 00
Washington	1									500 00

These tables show the total expenditure in the various districts for different classes of supplies. Under the head of "sundries" is included a large number of articles, such as lubricating oil, hardware, ice, water, etc. In a considerable number of cases the total cost of supplies only was reported, and has been entered under "sundries". At a great number of mines, however, the managers were unable to furnish the information requested.

TABLE XLV.—DEEP MINES: TOTAL COST OF SUPPLIES, BEING A SUMMARY OF TABLE XLIV.

State or territory and county.	Number of mines reported.	Total cost of supplies.
ALABAMA.		
Cleburne	1	$142 00
Talladega	1	50 00
ARIZONA.		
Maricopa	2	8,476 00
Mohave	1	120 00
Pima	14	33,476 00
Pinal	3	4,489 00
Yuma	1	1,759 00
CALIFORNIA.		
Amador	4	87,059 50
El Dorado	2	8,686 70
Inyo	6	28,825 56
Lassen	3	11,404 00
Mariposa	1	4,555 50
Mono	18	181,063 43
Nevada	5	16,312 20
Placer	1	1,370 00
Plumas	6	34,201 94
San Bernardino	2	4,455 00
Siskiyou	3	23,761 31
Tuolumne	2	4,775 00
COLORADO.		
Boulder	10	42,151 40
Chaffee	2	257 70
Clear Creek	31	56,019 78
Custer	7	28,323 50
Gilpin	25	97,463 73
Gunnison	1	1,369 50
Hinsdale	3	2,070 10
Huerfano	1	890 00
Lake	21	343,425 17
Ouray	16	6,476 63
Park	9	9,648 74
Rio Grande	1	274 00
San Juan	18	29,476 77
Summit	4	10,170 50
DAKOTA.		
Custer	9	$4,379 00
Lawrence	41	242,128 45
Pennington	7	2,360 20
GEORGIA.		
Cherokee	2	273 30
Cobb	1	305 00
Forsyth	1	1,290 30
Hall	2	656 75
Lincoln	2	1,128 20
McDuffie	1	661 24
Meriwether	1	565 47
IDAHO.		
Alturas	12	15,403 71
Boisé	6	18,638 25
Lemhi	2	3,977 40
Owyhee	8	15,170 20
MAINE.		
Hancock	1	2,100 00
Penobscot	2	2,842 50
Washington	1	690 00
MONTANA.		
Beaver Head	8	6,305 00
Deer Lodge	24	105,170 80
Jefferson	4	2,322 75
Lewis and Clarke	5	7,015 45
Madison	5	1,950 05
NEVADA.		
Elko	11	115,692 10
Esmeralda	10	58,242 76
Eureka	18	180,090 82
Humboldt	2	2,418 00
Lander	1	8,784 00
Lincoln	1	58,545 00
Nye	3	27,912 00
Storey and Lyon	32	2,205,832 30
White Pine	4	77,531 92
NEW MEXICO.		
Grant	10	$6,703 22
Santa Fé	1	118 25
NORTH CAROLINA.		
Davidson	4	10,599 40
Gaston	1	2,657 50
Guilford	1	241 45
Mecklenburg	2	4,306 85
Moore	1	903 00
Nash	1	600 00
Rowan	1	2,382 30
Stanley	1	200 00
OREGON.		
Baker	6	36,494 26
Grant	2	3,187 00
Josephine	1	146 50
UTAH.		
Beaver	11	55,465 78
Juab	7	14,414 00
Pi Ute	2	2,000 00
Salt Lake	41	132,287 92
Summit	6	86,213 66
Tooele	12	17,912 57
Utah	6	6,225 00
Wasatch	7	16,879 50
Washington	7	21,194 71
VIRGINIA.		
Buckingham	1	700 00
Culpeper	1	364 05
Fauquier	1	2,000 00
Louisa	1	894 00
Stafford	1	600 00
WASHINGTON.		
Yakima	1	500 00

TABLE XLVI.—DEEP MINES: TOTAL COST OF SUPPLIES.

RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	Number of mines reported.	Total cost of supplies.
Total	589	$4,681,287 56
Alabama	2	192 00
Arizona	21	48,320 00
California	53	406,470 14
Colorado	149	628,017 52
Dakota	57	248,867 65
Georgia	10	4,804 32
Idaho	28	53,189 56
Maine	4	5,632 50
Montana	46	122,764 05
Nevada	82	2,735,648 90
New Mexico	11	6,911 47
North Carolina	12	21,890 50
Oregon	9	39,827 76
Utah	99	353,673 14
Virginia	5	4,558 05
Washington	1	500 00

Nearly 600 mines reported their expenditure for supplies, amounting to about $4,700,000. The number of mines reporting is only a fraction of the total number of deep precious-metal mines of the country, but it must be remembered that the table includes almost all the great consumers. A single one of the larger mines of the Comstock spends more for supplies than scores of small mines elsewhere. It is probable, therefore, that nearly one-half of the total is included in the table, and that the whole amount expended in this way is between nine and ten millions annually.

There is no relation between consumption of supplies and production. The comparatively new and shallow mines of Colorado now produce much more than the older and deeper mines of Nevada, but they consume far less. It is to be remarked, however, that, as appears from Table XLII, the prices in Nevada are much higher than those of Colorado.

TABLE XLVII.—DEEP MINES: SUPPLIES BROUGHT TO THE COMSTOCK TOWNS DURING THE CALENDAR YEAR 1879, AND ESTIMATED MODES OF CONSUMPTION.

Character.	Unit.	Total amount.	Mine use.	Mill use.	Permanent construction.	Domestic use.
Wood	Cords	185, 622½	110, 000	40, 000		35, 622½
Timber	Board feet	31, 443, 771	25, 000, 000			6, 443, 771
Iron	Pounds	2, 373, 919	873, 919	1, 500, 000		
Steel	do	183, 366	122, 244	61, 122		
Candles	do	725, 092	725, 092			
Powder	do	520, 319	520, 319			
Fuse	do	51, 594	51, 594			
Mining machinery	do	5, 910, 355			5, 910, 355	
Nails	do	462, 442			462, 442	
Nuts	do	32, 514			32, 514	
Pipe	do	1, 008, 808			1, 008, 808	
Shovels	do	29, 251	27, 251	1, 000		1, 000
Lard oil	Gallons	119, 207	89, 405	29, 802		
Lubricating oil	do	16, 672	11, 115	5, 557		
Quicksilver	Pounds			300, 000		
Salt	do			2, 500, 000		
Bluestone	do			450, 000		

TABLE XLVIII.—DEEP MINES: COST OF MINE AND MILL SUPPLIES CONSUMED ON THE COMSTOCK DURING THE CALENDAR YEAR 1879.

Character.	Mine use.	Mill use.	Total.
Total	$2, 205, 832 30	$813, 026 76	a $3, 018, 859 06
Wood	1, 100, 000 00	400, 000 00	1, 500, 000 00
Timber	500, 000 00		500, 000 00
Iron	52, 435 14	90, 000 00	142, 435 14
Steel	22, 003 92	11, 001 96	33, 005 88
Candles	123, 265 04		123, 265 04
Explosives	208, 127 60		208, 127 60
Quicksilver		135, 000 00	135, 000 00
Salt		25, 000 00	25, 000 00
Bluestone		45, 000 00	45, 000 00
Lard-oil	89, 405 00	29, 802 00	119, 207 00
Lubricating oil	4, 446 00	2, 222 80	6, 668 80
Sundries	b 106, 149 00	c75, 000 00	181, 149 00

a Does not include machinery, etc., entering into permanent construction.
b Including ice, water, charcoal, coal-oil, stone coal, tools, etc.
c Including water, tools, light, chemicals, etc.

Virginia City is not a distributing point, and almost all supplies brought there are consumed in the district. The consumption of supplies on the Comstock has been investigated with much care, and some of the results are introduced here by way of illustration. On the Comstock vast quantities of ice are consumed, because, owing to the high temperature of the mines, the men must be supplied freely with ice-water for sponging head and arms, as well as for drinking, but in most other respects the consumption of supplies is what may be expected in other very deep mines.

ACCIDENTS IN THE CENSUS YEAR; THEIR CAUSES AND RESULTS.

TABLE XLIX.—DEEP MINES: FATAL ACCIDENTS.

State or territory.	Total.	CAUSE.											
		Caving, fall of roof, etc.	Falls unconnected with hoisting machinery.	Premature explosions.	From unexploded charges.	Falling of cages, buckets, etc.	Falling from cages, buckets, etc.	Fire.	Suffocation not caused by fire.	Crushed by cages, cars, etc.	Struck by falling timbers, buckets, etc.	Overwinding of cages, etc.	Unclassified.
The United States	123	25	27	16	2	11	7	9	4	7	4	2	9
Arizona	5			3	1	1							
California	30	5	8			7			1	2	2		5
Colorado	21	9	4	4			1			1	1		1
Dakota	12	1	3	6		1	1						
Montana	3	2	1										
Nevada	28	3	7	2		1	4	3	1	2	1	2	2
North Carolina	2		2										
Utah	21	4	2	2	1		1	6	2	2			1
Wyoming	1	1											

TABLE L.—DEEP MINES: ACCIDENTS NOT FATAL.

State or territory.	Total.	CAUSE.												
		Caving, fall of roof, etc.	Premature explosions.	From unexploded charges.	Falls unconnected with hoisting machinery.	Falling of cages, buckets, etc.	Falling from cages, buckets, etc.	Crushed by cages, cars, etc.	Struck by falling timbers, buckets, etc.	Overwinding of cages, etc.	Caught by machinery.	Carelessness in handling tools.	Loading.	Unclassified.
The United States	312	110	39	4	26	13	5	6	12	17	11	8	35	26
Alabama	1									1				
Arizona	6				1	2	1							2
California	39	19	9		2	3	1		1		1	1		2
Colorado	87	39	22	1	8	3	1	2	2			2		7
Dakota	11	3	5		1				1			1		
Georgia	2				1									1
Idaho	1	1												
Maine	5		1		3				1					
Montana	5	3			1									1
Nevada	51	13	1		4	1	2	4	4	15	4	1		2
North Carolina	8					3					5			
Oregon	4	3												1
Utah	86	24	1	3	5	1			3	1		3	35	10
Virginia	1										1			
Wyoming	5	5												

TABLE LI.—DEEP MINES: TOTAL ACCIDENTS.

State or territory.	Total.	CAUSE.														
		Caving, fall of roof, etc.	Premature explosions.	Falls unconnected with hoisting machinery.	Loading.	Falling of cages, buckets, etc.	Overwinding of cages, buckets, etc.	Struck by falling timbers, buckets, etc.	Crushed by cages, cars, etc.	Falling from cages, buckets, etc.	Caught by machinery.	Fire.	Carelessness in handling tools.	From unexploded charges.	Suffocation not caused by fire.	Unclassified.
The United States	435	135	55	53	35	24	19	16	13	12	11	9	8	6	4	35
Alabama	1						1									
Arizona	11		2	1		4				1				1		2
California	69	24	9	10		10		3	2	1	1		1		1	7
Colorado	108	48	26	12		3		3	3	2			2	1		8
Dakota	23	4	11	4		1		1		1			1			
Georgia	2			1												1
Idaho	1	1														
Maine	5		1	3				1								
Montana	8	5		2												1
Nevada	79	16	3	11		2	17	5	6	6	4	3	1		1	4
North Carolina	10			2		3					5					
Oregon	4	3														1
Utah	107	28	3	7	35	1	1	3	2	1		6	3	4	2	11
Virginia	1										1					
Wyoming	6	6														

TABLE LII.—ALL MINES (DEEP AND PLACER): ACCIDENTS.

State or territory.	Total.	RESULT.	
		Fatal.	Not fatal.
The United States	472	136	336
Alabama	1	.....	1
Arizona	12	5	7
California	97	39	58
Colorado	109	22	87
Dakota	24	13	11
Georgia	2	.....	2
Idaho	2	.....	2
Maine	5	.....	5
Montana	8	3	5
Nevada	79	28	51
North Carolina	10	2	8
Oregon	9	2	7
Utah	107	21	86
Virginia	1	.....	1
Wyoming	6	1	5

TABLE LIII.—DEEP MINES: ACCIDENTS.

Cause.	Total.	RESULT.	
		Fatal.	Not fatal.
Total	435	123	312
Caving, fall of roof, etc	125	25	110
Premature explosions	55	16	39
Falls unconnected with hoisting machinery	53	27	26
Leading (a)	35	.....	35
Falling of cages, buckets, etc	24	11	13
Overwinding of cages, buckets, etc	19	2	17
Struck by falling timbers, buckets, etc	16	4	12
Crushed by cages, cars, etc	13	7	6
Falling from cages, buckets, etc	12	7	5
Caught by machinery	11	.....	11
Fire	9	9	.....
Carelessness in handling tools	8	.....	8
From unexploded charges	6	2	4
Suffocation not caused by fire	4	4	.....
Unclassified	35	9	26

a Leading, or sickness caused by the inhalation of carbonate dust in dry lead mines, and also of lead fumes about metallurgical works, is much more frequent than appears from this exhibit. The small number of cases included under this head includes merely such serious injuries as occurred in mines reported by special schedule.

TABLE LIV.—DEEP MINES: PERCENTAGE OF DIFFERENT CLASSES OF ACCIDENTS.

Cause.	PERCENTAGE FROM EACH CAUSE IN—		
	Total accidents.	Fatal accidents.	Accidents not fatal.
Total	100.00	100.00	100.00
Caving, fall of roof, etc	31.03	20.33	35.26
Premature explosions	12.64	13.01	12.50
Falls unconnected with hoisting machinery	12.18	21.95	8.33
Leading	8.05	.....	11.22
Falling of cages, buckets, etc	5.51	8.94	4.17
Overwinding of cages, buckets, etc	4.37	1.62	5.45
Struck by falling timbers, buckets, etc	3.68	3.25	3.85
Crushed by cages, cars, etc	2.99	5.69	1.92
Falling from cages, buckets, etc	2.76	5.69	1.60
Caught by machinery	2.53	.....	3.53
Fire	2.07	7.32	.....
Carelessness in handling tools	1.84	.....	2.56
From unexploded charges	1.38	1.62	1.25
Suffocation not caused by fire	0.92	3.25	.....
Unclassified	8.05	7.32	8.33

TABLE LV.—DEEP MINES: PERCENTAGE OF FATALITY IN EACH CLASS OF ACCIDENTS.

Cause.	PERCENTAGE.	
	Fatal accidents.	Accidents not fatal.
Total	28.28	71.72
Caving, fall of roof, etc	18.52	81.48
Premature explosions	29.09	70.91
Falls unconnected with hoisting machinery	50.94	49.06
Leading		100.00
Falling of cages, buckets, etc	45.83	54.17
Overwinding of cages, buckets, etc	10.53	89.47
Struck by falling timbers, buckets, etc	25.00	75.00
Crushed by cages, cars, etc	53.85	46.15
Falling from cages, buckets, etc	58.33	41.67
Caught by machinery		100.00
Fire	100.00	
Carelessness in handling tools		100.00
From unexploded charges	33.33	66.67
Suffocation not caused by fire	100.00	
Unclassified	25.71	74.29

TABLE LVI.—DEEP MINES: PROPORTION OF ACCIDENTS TO NUMBER OF MINES REPORTED, ACCORDING TO CAUSE.

Cause.	TOTAL ACCIDENTS.		FATAL ACCIDENTS.		ACCIDENTS NOT FATAL.	
	Ratio to total number of mines reported.	Ratio to number of mines returning definite answers.	Ratio to total number of mines reported.	Ratio to number of mines returning definite answers.	Ratio to total number of mines reported.	Ratio to number of mines returning definite answers.
Total	1: 1.84	1: 1.74	1: 6.50	1: 6.15	1: 2.56	1: 2.43
Caving, fall of roof, etc	1: 5.93	1: 5.61	1: 32.00	1: 30.28	1: 7.27	1: 6.88
Premature explosions	1: 14.55	1: 13.76	1: 50.00	1: 47.31	1: 20.51	1: 19.41
Falls unconnected with hoisting machinery	1: 15.09	1: 14.28	1: 28.63	1: 28.04	1: 30.77	1: 29.11
Leading	1: 22.86	1: 21.63	0: 800.00	0: 757.00	1: 22.86	1: 21.63
Falling of cages, buckets, etc	1: 33.33	1: 31.54	1: 72.73	1: 68.82	1: 61.54	1: 58.22
Overwinding of cages, buckets, etc	1: 42.10	1: 39.84	1: 400.00	1: 378.50	1: 47.06	1: 44.53
Struck by falling timbers, buckets, etc	1: 50.00	1: 47.31	1: 200.00	1: 189.25	1: 66.67	1: 63.08
Crushed by cages, cars, etc	1: 61.54	1: 58.22	1: 114.28	1: 108.14	1: 133.33	1: 126.17
Falling from cages, buckets, etc	1: 66.67	1: 63.08	1: 114.28	1: 108.14	1: 160.00	1: 151.40
Caught by machinery	1: 72.73	1: 68.82	0: 800.00	0: 757.00	1: 72.73	1: 68.82
Fire	1: 88.89	1: 84.11	1: 88.89	1: 84.11	0: 800.00	0: 757.00
Carelessness in handling tools	1: 100.00	1: 94.63	0: 800.00	0: 757.00	1: 100.00	1: 94.63
From unexploded charges	1: 133.33	1: 126.17	1: 400.00	1: 378.50	1: 200.00	1: 189.25
Suffocation not caused by fire	1: 200.00	1: 189.25	1: 200.00	1: 189.25	0: 800.00	0: 757.00
Unclassified	1: 22.86	1: 21.63	1: 88.89	1: 84.11	1: 30.77	1: 29.11

TABLE LVII.—DEEP MINES: PROPORTION OF ACCIDENTS TO NUMBER OF MINES REPORTED, ACCORDING TO LOCALITY.

State or territory.	TOTAL ACCIDENTS.		FATAL ACCIDENTS.		ACCIDENTS NOT FATAL.	
	Ratio to total number of mines reported.	Ratio to number of mines returning definite answers.	Ratio to total number of mines reported.	Ratio to number of mines returning definite answers.	Ratio to total number of mines reported.	Ratio to number of mines returning definite answers.
The United States	1: 1.84	1: 1.74	1: 6.50	1: 6.15	1: 2.56	1: 2.43
Alabama	1: 2.00	1: 2.00	0: 2.00	0: 2.00	1: 2.00	1: 2.00
Arizona	1: 5.45	1: 5.27	1: 12.00	1: 11.60	1: 10.00	1: 9.67
California	1: 1.30	1: 1.19	1: 3.00	1: 2.73	1: 2.31	1: 2.10
Colorado	1: 2.33	1: 2.18	1: 12.00	1: 11.24	1: 2.89	1: 2.71
Dakota	1: 2.52	1: 2.52	1: 4.83	1: 4.83	1: 5.27	1: 5.27
Georgia	1: 5.00	1: 4.50	0: 10.00	0: 9.00	1: 5.00	1: 4.50
Idaho	1: 35.00	1: 35.00	0: 35.00	0: 35.00	1: 35.00	1: 35.00
Maine	1: 1.60	1: 1.40	0: 8.00	0: 7.00	1: 1.60	1: 1.40
Montana	1: 8.87	1: 8.75	1: 23.67	1: 23.33	1: 14.20	1: 14.00
Nevada	1: 0.85	1: 0.85	1: 2.39	1: 2.39	1: 1.31	1: 1.31
New Hampshire	0: 3.00	0: 2.00	0: 3.00	0: 2.00	0: 3.00	0: 2.00
New Mexico	0: 14.60	0: 12.00	0: 14.00	0: 12.00	0: 14.00	0: 12.00
North Carolina	1: 1.20	1: 1.20	1: 6.00	1: 6.00	1: 1.50	1: 1.50
Oregon	1: 2.25	1: 2.25	0: 9.00	0: 9.00	1: 2.25	1: 2.25
Utah	1: 0.84	1: 0.82	1: 4.29	1: 4.19	1: 1.05	1: 1.02
Virginia	1: 5.00	1: 5.00	0: 5.00	0: 5.00	1: 5.00	1: 5.00
Washington	0: 1.00	0: 1.00	0: 1.00	0: 1.00	0: 1.00	0: 1.00
Wyoming	1: 2.17	1: 0.67	1: 13.00	1: 4.00	1: 2.60	1: 0.80

TABLE LVIII.—DEEP MINES: ACCIDENTS—RATIO OF MEN KILLED OR INJURED TO NUMBER EMPLOYED, ACCORDING TO CAUSE.

Cause.	RATIO OF MEN KILLED OR INJURED TO NUMBER EMPLOYED.		
	Total accidents.	Fatal accidents.	Accidents not fatal.
Total	1: 44.02	1: 155.67	1: 61.37
Caving, fall of roof, etc	1: 141.83	1: 765.88	1: 174.06
Premature explosions	1: 248.13	1: 1,106.00	1: 490.95
Falls unconnected with hoisting machinery	1: 361.26	1: 709.15	1: 736.42
Leading	1: 547.06	0: 19,147.00	1: 547.06
Falling of cages, buckets, etc	1: 797.79	1: 1,740.63	1: 1,472.84
Overwinding of cages, buckets, etc	1: 1,007.74	1: 9,573.50	1: 1,129.30
Struck by falling timbers, buckets, etc	1: 1,196.09	1: 4,786.75	1: 1,595.58
Crushed by cages, cars, etc	1: 1,472.84	1: 2,735.28	1: 2,191.17
Falling from cages, buckets, etc	1: 1,595.58	1: 2,735.28	1: 3,829.40
Caught by machinery	1: 1,740.63	0: 19,147.00	1: 1,740.63
Fire	1: 2,127.44	1: 2,127.44	0: 19,147.00
Carelessness in handling tools	1: 2,393.87	0: 19,147.00	1: 2,393.87
From unexploded charges	1: 3,191.17	1: 9,573.50	1: 4,786.75
Suffocation not caused by fire	1: 4,786.75	1: 4,786.75	0: 19,147.00
Unclassified	1: 847.00	1: 2,127.44	1: 736.42

TABLE LIX.—DEEP MINES: ACCIDENTS—RATIO OF MEN KILLED OR INJURED TO NUMBER EMPLOYED, ACCORDING TO LOCALITY.

State or territory.	RATIO OF MEN KILLED OR INJURED TO NUMBER EMPLOYED.		
	Total accidents.	Fatal accidents.	Accidents not fatal.
The United States	1: 44.02	1: 155.67	1: 61.37
Alabama	1: 17.00	0: 17.00	1: 17.00
Arizona	1: 77.56	1: 170.00	1: 142.17
California	1: 45.78	1: 105.30	1: 81.00
Colorado	1: 56.67	1: 291.43	1: 70.34
Dakota	1: 41.74	1: 80.00	1: 67.27
Georgia	1: 72.50	0: 145.00	1: 72.50
Idaho	1: 431.00	0: 431.00	1: 431.00
Maine	1: 26.20	0: 131.00	1: 26.20
Montana	1: 145.50	1: 393.00	1: 232.80
Nevada	1: 44.96	1: 126.79	1: 60.61
New Hampshire	0: 26.00	0: 26.00	0: 26.00
New Mexico	0: 215.00	0: 215.00	0: 215.00
North Carolina	1: 82.90	1: 204.50	1: 66.13
Oregon	1: 29.00	0: 116.00	1: 29.00
Utah	1: 14.30	1: 72.86	1: 17.79
Virginia	1: 105.00	0: 105.00	1: 105.00
Washington	0: 7.00	0: 7.00	0: 7.00
Wyoming	1: 14.83	1: 88.00	1: 17.60

These tables are based upon the entire number of miners reported, 19,147, employed in 693 mines. Calculated per thousand men, the entire number of accidents during the census year for these mines was $22\frac{7}{10}$, of which $6\frac{4}{10}$ were fatal, and $16\frac{3}{10}$ caused only temporary disability. This proportion would have been very much reduced had the investigation included all the small mines, for, as will appear by inspecting the table of causes, a very large proportion of the accidents is connected with hoisting machinery. Taking this fact into consideration, the number of accidents compares favorably with that which occurs in European countries, where the mines are subjected to frequent and rigid inspection by government officers for the express purpose of insuring safety to the miners. In 1875, $2\frac{6}{100}$ per 1,000 employed in the French mines were reported as killed and $17\frac{11}{100}$ per 1,000 as wounded.

The most fruitful causes of accidents are the caving or falling of roofs and falls connected with hoisting machinery. "Leading" is a source of accidents not met with in most mining countries. It occurs in lead mines which are so dry that the ore fills the air as dust. This is the case only above the water-level, which, however, in many mines of the Great Basin, is several hundred feet below the surface. On the Comstock about 12 per cent. of the accidents are due to heat.

CHAPTER IV.—PLACER MINES.

TOPOGRAPHICAL.

POSITION RELATIVE TO SOURCES OF WATER SUPPLY.—This is a decisive question with regard to mines worked by the hydraulic method, for which an abundant water supply is as essential to successful results as is the possession of an auriferous gravel deposit. Drift mines require much less water, but it is none the less a necessity. As it frequently happens that erosion has left the gravel beds at elevations far above the existing drainage system in their immediate vicinity, and sometimes in isolated positions, as at Cherokee and many other places in California, the introduction of artificial water channels becomes a problem of great difficulty, to meet which capital and engineering skill are taxed to their fullest extent. The section on mining ditches contains illustrations of the nature of the work already accomplished in this direction.

POSITION RELATIVE TO LINES OF COMMUNICATION.—The more important placers are in portions of the country which, as a rule, are more accessible and thickly settled than the quartz-mining districts, and are often found in immediate proximity to fertile agricultural land, to which population was originally attracted by the existence of mines. Hence, the prices of food and other necessaries of life are comparatively low. Placer mines, too, do not require nearly so large an amount of material as do quartz mines and mills. Beyond the light iron pipes, hose, tools, quicksilver, and occasionally powder for bank-blasting, the amount of supplies to be brought as freight is usually very small, except in cases where mines are opened by extensive tunnel enterprises. The question of freight charges is therefore one of minor importance, except in certain remote districts in Idaho, Montana, and Dakota, or the Skagit country in Washington.

ALTITUDE REFERRED TO SEA-LEVEL.—The secondary nature of gravel deposits in itself implies a lower average altitude than that of quartz veins, from which they are derived, though exceptions are met with in the case of veins unrelated to the drift matter or whose croppings have been largely cut down by erosion, possibly also where the conditions have been reversed by earth movements. The placer mines reported upon are at an average elevation of over 3,400 feet above sea-level, and those of California alone are at an elevation of about 2,600 feet. The large number of shallow alluvial placers on the foot-hills and on the edges of the Sacramento and San Joaquin valleys, not on the lines of ancient river channels but re-deposits from the latter, are at less altitudes than the average stated, while the beach sands, which are not included in this computation, form the lowest group. The great drifts of the ancient rivers are in places from 1,500 to 2,000 feet above the present drainage system. The order of succession of the deposits in point of time as well as of altitude is: first, the original quartz veins; second, the drift accumulated in the ancient river channels; third, the shallow alluvial placers, a re-deposit or second concentration from the earlier drifts. Above the zone of the ancient rivers, in places, are found deposits of wash from the quartz croppings of recent origin; and, on the other hand, below the old river beds occasional accumulations of gravel are found, which are not re-deposits from the latter, but are formed by the disintegration of veins which reach the surface at a less elevation than that of the ancient channels.

Placers are sometimes by erosion left at the summits of hills or mountains, but this is the exception, not the rule, though some very important deposits occur on the crests of the foot-hills.

Alma township, in Park county, Colorado, contains the highest placer reported. Its elevation is stated at 10,000 feet.

Tables are annexed showing the results, in reference to altitude, reached from an examination of 174 working placer mines.

TABLE LX.—ALTITUDE OF PLACER MINES, BY DISTRICTS.

State, county, and district.	No. of mines reported.	Average altitude.
ARIZONA.		
APACHE CO.		
Greenlee Gold Mountain	1	4,000
CALIFORNIA.		
BUTTE CO.		
Cherokee Flat	1	1,110
Magalia, or Dog Town	1	2,650
Morris Ravine	1	900
Oroville	1	165
DEL NORTE CO.		
Indian Creek	7	1,796
PLACER CO.		
Dutch Flat	1	3,500
Gold Run	1	3,400
Iowa Hill	1	2,830
Michigan Bluffs	2	3,549
PLUMAS CO.		
Moonlight Mountain	1	5,433
Seneca	2	4,142
	3	5,732
SISKIYOU CO.		
Galena Hill	1	2,500
Humbug	2	2,850
Indian Creek	3	2,693
McAdams Creek	7	2,707
Oro Fino	1	2,200
Sawyer's Bar	1	2,200
Scad Valley	2	1,497
Scott Valley	1	3,200
Yreka	8	2,831
STANISLAUS CO.		
La Grange	1	200
COLORADO.		
CHAFFEE CO.		
Hope	1	8,600
CLEAR CREEK CO.		
Grass Valley	1	7,000
Jackson	1	7,500
LAKE CO.		
California	2	9,975
LA PLATA CO.		
California	1	8,400
PARK CO.		
Alma township	1	10,000
SUMMIT CO.		
Bevan	1	9,700
Spaulding	1	9,250
	1	9,800
DAKOTA.		
CUSTER CO.		
Battle Creek	1	4,400
LAWRENCE CO.		
Bear Gulch	1	*a* 6,000
PENNINGTON CO.		
Confederate	2	4,075
Cañon	3	4,200
Jenny and Strawberry	1	5,500
Rockerville	1	5,500
Ruby	1	4,200
GEORGIA.		
CHEROKEE CO.		
Fifteenth and Second	1	881
HALL CO.		
810 G. M., Ninth and Twelfth	1	1,400
LUMPKIN CO.		
Twelfth	3	1,862
Twelfth and First	2	1,530
Thirteenth	1	1,420
UNION CO.		
Tenth and First	1	2,000
WHITE CO.		
Third	1	2,000
Fourth	1	*a* 2,000

State, county, and district.	No. of mines reported.	Average altitude.
IDAHO.		
ALTURAS CO.		
Elk Creek, or Hardscrabble	1	5,700
BOISÉ CO.		
Boston	1	5,300
Moore's Creek	3	5,066
Pioneer	2	5,725
MONTANA.		
BEAVER HEAD CO.		
Bannock	2	5,000
DEER LODGE CO.		
Gold Hill	1	5,400
Henderson Gulch	1	*a* 5,600
Independence	1	*a* 5,800
McClellan Gulch	2	*a* 6,100
Nelson	1	*a* 4,500
Summit Valley	1	*a* 5,700
LEWIS AND CLARKE CO.		
Last Chance	1	*a* 4,200
MEAGHER CO.		
German	1	4,400
Thompson Gulch	3	6,300
NORTH CAROLINA.		
MONTGOMERY CO.		
Eldorado	1	440
	1	780
OREGON.		
BAKER CO.		
Amelia	1	4,000
Blue Cañon	2	3,050
Chicken Creek	2	3,250
Humboldt Basin	1	4,500
Mormon Basin	1	5,000
Pocahontas	3	4,333
Rye Valley	1	3,000
Shasta	3	3,500
Sumter	1	4,000
Wilson Creek	1	3,000
DOUGLAS CO.		
Big Bend Cow Creek	4	1,181
Cañonville	2	580
Green Mountain	2	2,000
GRANT CO.		
Cañon City	2	4,200
Elk Creek	1	4,200
Granite	2	6,350
Marysville	5	4,800
Rock Creek	2	3,880
Trail Creek	1	7,000
JACKSON CO.		
Applegate	2	2,000
Ashland	1	1,850
Coyote Creek	2	1,350
Farris Gulch	1	1,600
Fort Lane	1	1,700
Forty-nine	2	2,350
Sam's Valley	1	1,760
Sterling	2	2,425
Uniontown	2	1,000
Wolf Creek	1	1,500
JOSEPHINE CO.		
Althouse	2	1,500
Cañon Creek	1	1,600
Grass Creek	2	1,500
Josephine	1	1,600
Murphy	1	1,600
Silver Creek	1	1,900
Waldo	2	1,550
Yank	2	1,650
	1	800
WASCO CO.		
Ochoco	1	3,800
SOUTH CAROLINA.		
CHESTERFIELD CO.		
	1	650
UTAH.		
SALT LAKE CO.		
West Mountain	1	6,000
WASHINGTON.		
YAKIMA CO.		
Swauk	1	2,000

a Estimated.

TABLE LXI.—POSITION OF PLACER MINES IN ZONES OF ALTITUDE.

State or territory.	Total number of mines reported.	Under 500 feet.	Over 500 feet and under 1,000 feet.	Over 1,000 feet and under 1,500 feet.	Over 1,500 feet and under 2,000 feet.	Over 2,000 feet and under 2,500 feet.	Over 2,500 feet and under 3,000 feet.	Over 3,000 feet and under 3,500 feet.	Over 3,500 feet and under 4,000 feet.	Over 4,000 feet and under 4,500 feet.	Over 4,500 feet and under 5,000 feet.	Over 5,000 feet and under 5,500 feet.	Over 5,500 feet and under 6,000 feet.	Over 6,000 feet and under 6,500 feet.	Over 6,500 feet and under 7,000 feet.	Over 7,000 feet and under 7,500 feet.	Over 7,500 feet and under 8,000 feet.	Over 8,000 feet and under 8,500 feet.	Over 8,500 feet and under 9,000 feet.	Over 9,000 feet and under 9,500 feet.	Over 9,500 feet and under 10,000 feet.	10,000 feet.
The United States	174	3	8	17	25	15	20	11	12	14	13	9	7	7	1	2	2	1	1	1	3	2
Arizona	1									1												
California	49	2	1	5	5	5	19	4	5	1	1	1										
Colorado	10																2	1	1	1	3	2
Dakota	10									4	2	1	2	1								
Georgia	11		1	4	3	2		1														
Idaho	7										2	3	1	1								
Montana	14									2	1	3	4	3		1						
North Carolina	2	1	1																			
Oregon	67		4	8	17	7	1	6	7	6	7	1		1	1	1						
South Carolina	1		1																			
Utah	1													1								
Washington	1					1																

TABLE LXII.—RANGE AND MEAN OF ALTITUDES OF PLACER MINES REPORTED ON.

State or territory.	Highest.	Lowest.	Intermediate.	Mean.
	Feet.	*Feet.*	*Feet.*	*Feet.*
The United States	10,000	185	5,092	3,447
Arizona	4,000	4,000	4,000	4,000
California	a 5,433	b 185	2,809	2,612
Colorado	10,000	7,500	8,750	9,075
Dakota	c 6,000	c 4,000	5,000	4,795
Georgia	3,000	881	1,940	1,694
Idaho	d 5,700	4,800	5,250	5,254
Montana	e 7,000	4,200	5,600	5,484
North Carolina	780	440	610	610
Oregon	7,000	b 500	3,780	2,780
South Carolina	650	650	650	650
Utah	6,000	6,000	6,000	6,000
Washington	2,000	2,000	2,000	2,000

a Small placers in the Bodie district not included.
b Does not include black sand littoral deposits.
c Estimated.
d Small placers in Alturas and Lemhi counties 9,000 feet.

GEOLOGICAL.

FORM OF THE SURFACE OF GRAVEL DEPOSITS.—The topographical features of the auriferous alluvions vary widely with the nature and origin of the deposits and according to geological events succeeding the period of deposition. Deep placers are often left by erosion at the crests of hills in forms which from a distance give no indication of their existence, and may be cut through transversely by modern streams in such a manner that the original channel is only traceable by detached patches, which are not always clearly related. If covered by volcanic flows, and then subjected to erosion on a large scale, the deposit may assume the form of a table-mountain. Many blind leads, workable by drifting, doubtless exist which have not yet been discovered, owing to the completeness with which they have been covered over.

The shallow placers of wash from neighboring quartz croppings or formed from ancient channel deposits by more recent agencies are usually deposited in the gulches and creek beds as bars or irregularly rounded accumulations, or are spread thinly over the surface as a light wash on smooth slopes. A shallow, quite uniform loam is commonly found on the surface, supporting in places a vegetation which masks the character of the underlying deposit.

Prospectors are guided in their search by the indications found in creek beds, and in localities where the development of the mines has progressed to some extent they are enabled to locate the position of hidden deposits by their relationship to known channels.

DIMENSIONS OF THE CHANNELS.—The ancient channels are remarkable not only for the enormous carrying force shown by the frequent huge accumulations of bowlders, but also for their extent. In California these channels

represent rivers, and not glacial courses—a point which is quite satisfactorily established—and indicate an extinct fluvial system much greater than that now existing, and consequently a greater rainfall than the present. In Arizona and New Mexico gravel deposits of considerable size are found in regions where the water supply is now entirely insufficient for successful working. The course of the channels, too, is often at variance with that of existing streams, though the drainage system as a whole retains the same general character.

The deposit on which the Spring Valley mine, at Cherokee, California, is located is 9 miles long and from 1 to 2 miles wide. On the Spring Valley ground the gravel reaches 400 feet in depth and averages 200 feet. The Bonanza mine, at Mokelumne Hill, is on a channel 500 feet wide, traceable for 10 miles. The Wingate and Bunker Hill mines, in Del Norte county, are on a deposit from one-half to three-quarters of a mile in width, which is claimed to be traceable for 150 miles. The "blue lead" at the Gold Run mine, Placer county, is from 200 to 1,000 feet wide and in places 450 feet deep, and averages 350 feet deep; at the Polar Star the pay channel, 300 feet wide, is nearly as deep, while the Paragon mine has a deposit 800 feet wide, averaging 400 feet in depth, and in places is 600 feet deep. The channel at the Orion mine, in the same county, is said to be 2,000 feet wide, with a maximum depth of 180 feet, averaging 100 feet. In Plumas county the lead worked by the Plumas Mining and Water Company, half a mile wide, is 70 feet deep on an average and 120 feet in spots. In Stanislaus county the La Grange mine is on a deposit traceable for a mile in width and having a maximum depth at that mine of 300 feet. A lead running through Yuba county, traced from San Juan to Laporte, is 27 miles long, and at the Weed's Point mine, Galena Hill, is 600 feet wide, with an average depth of 75 feet. At Columbia Hill, Nevada county, the deposit has been estimated at between 600 and 620 feet in depth. Other places in California show examples of similarly vast alluvions, those known as "deep placers" ranging between 100 and 600 feet, with possibly still greater depths, though it cannot be stated that a greater depth than 200 feet is a frequent occurrence.

Boisé basin, in Idaho, furnishes another example of great magnitude. Here a deposit 3 miles wide and 4 miles long is worked. It is traceable in patches for a full length of 14 miles, and is certainly not less than 30 square miles in area. The depth ranges from a few inches only to possibly 250 feet, and, however formed, the deposit is immeasurably disproportionate to any existing motive force. In this territory and in Montana and Dakota many placers occur in places apparently unrelated to the present drainage system of an extent altogether out of proportion to the transporting power of the present streams.

KIND AND ORDER OF DEPOSITS RECOGNIZED IN GRAVEL.—The most common occurrence in deep placers is: At the surface (or immediately underlying a loam stratum or a volcanic capping) a fine wash, containing few bowlders, or even pebbles. This may be quite uniform throughout, or may consist of many strata of varying coarseness and alternations of sand, fine gravel, and clay seams. The lower portion, on the other hand, contains bowlders, of which the largest are commonly near and on bed-rock. This sizing of material, observable in beds which are considered unquestionably of fluvial origin, is the natural result of the change of grade of the channel as the latter gradually becomes filled. Each successive layer formed was equivalent to a lessening of the grade and a diminished carrying power, and consequently involved a further deposition of lighter particles. In addition to this cause, variations in the amount of water flowing at different times of the year leave their traces, freshets depositing a coarser detritus than the sluggish flow during the dry season. A similar lamination, corresponding to the seasons, is shown in some tailings deposits, where, the cause and effect being recent, the connection is readily traced.

The typical formation indicated is susceptible of many variations without departure from its leading features, but sometimes the divergence is so wide as to indicate the action of exceptional causes. Particularly is this the case where, in gravel beds apparently belonging to the same system, the higher contain heavy bowlders, while the lower are made up of strata of fine material, indicating a very slow current, or even perhaps a lacustrine deposit. Here the most natural supposition is that the bowlders were brought down by exceptional freshets.

As a rule, the shallow alluvial placers and river beds do not show the same regularity as the deep leads, and often no stratification is perceptible.

LAVA-CAP.—Very many of the deep placers of California are overlaid wholly or in part by a capping of volcanic rock. This is usually a basalt, and all such cappings are locally known as "basalt". The lithological character of the rock has not been minutely studied as yet, but the occurrence of augite-andesite is suspected. The flow varies in depth from a few feet to a thickness of several hundred feet, extending over large areas, and sometimes for considerable distances is quite uniform in thickness.

A number of placer mines are so situated that, a portion being overlaid by lava while another part of the gravel is exposed, they are worked both by the hydraulic method and by drifting. If the whole ground is heavily capped, there is, of course, no alternative, and drifting is resorted to if the gravel is sufficiently rich.

OCCURRENCE OF WATER AND QUICKSAND.—At the lowest depths of the old channels seepage water sometimes accumulates, and precaution is necessary when the deposit is tapped from beneath by an upraise from a tunnel. The accumulation of water sometimes gives rise to quicksands, which are extremely troublesome.

BED-ROCK.—In California this is commonly slate, shale, or schist, but sometimes it is granite or sandstone, and more rarely limestone. The slates, etc., are of various colors (brown, blue, green, or black), and are usually soft (talcose or chloritic), but a fine-grained siliceous blue or black slate also occurs, which is rather hard. The granite is soft and decomposed, and slacks rapidly on exposure. In Oregon, Colorado, and Montana similar rocks occur.

In Idaho the common bed-rock is a highly decomposed granite, which is firm when first uncovered, but soon disintegrates on exposure to the air. In Dakota slate prevails, as also granite and sandstone. In the southern gold belt of Georgia, North Carolina, and South Carolina the bed-rock is usually a soft, decomposed mica-schist, which is highly siliceous, and often contains stringers of quartz, though a hard slate is also met with. In this portion of the country the "bed-rock" itself is mined. The disintegration of the surface by decomposition and weathering gives rise to a loose material which may be "hydraulicked", but which is not usually of the same character as the western gravel deposits, the latter often occurring at considerable distance from their origin.

The form of the surface of the bed-rock is a matter of considerable importance in working. A rough, uneven bed increases the labor of cleaning up, and if very irregular may suddenly leave the sluices "out of grade" at points where the pay is richest. In drift mines operations are facilitated by a regularity in the formation, while the drainage and extraction of ore are obstructed by a reverse condition.

FALSE BED-ROCKS.—Strata of indurated clay, or of dead gravel cement, occur frequently in gravel deposits, forming what are known as false bed-rocks. Sometimes it happens that below such a stratum the deposit, consisting of "dead wash", is too poor to pay for washing, or that the grade will not admit of deeper working; in such cases the seam is treated as a working bed-rock, and the tougher and more uniform it is the better. A number of profitable mines are operated on this plan, working off only the top pay streak down to a false bed-rock; but in more numerous cases, where it is desirable to "bottom" the entire deposit for the sake of winning the richer gravel on the true bed-rock and the gold lying in the crevices of the latter, the occurrence of the false bed-rocks is a great hinderance. Some clays are so tenacious as to yield but slowly to the pipe, and often blasting has to be resorted to, thus increasing the expense.

CHANGE IN THE DEPOSIT AT THE WATER-LEVEL.—In deep placers the upper strata of gravel and bowlders, when subject to the action of the atmosphere, are commonly reddish or yellowish in color. This is due to the peroxidation of the iron in the quartz. Below the water-level a deposit of blue gravel occurs. This, on prolonged exposure to the air, also changes color. In many famous mines the blue gravel, being the deeper and therefore presumably the richer, is the paying portion of the deposit; hence the popularity of "blue leads", which, indeed, have proved highly remunerative. In them, however, the color is not in itself an indication of richness beyond the fact that it points to a position protected from the air; that is, a comparatively deep one. Red gravel, too, occurs in depth. It is hardly necessary to add that changes in the position of the water-level may have obscured the color line.

OCCURRENCE OF GOLD.—The manner in which gold particles are distributed in gravel has been made a subject of close study by thoughtful miners, for upon a knowledge of the exact location of the paying portion of the mass often depends the method of working. Careful experiments should be made by panning; and the result of actual workings, when the product from different layers can be segregated in separate clean-ups, should be noted. The matter is one for serious consideration, and all the more so because of the present uncertainty as to the laws determining the occurrence of the "pay".

In a great majority of cases where the character of the deposit has been definitively established the preponderance of gold is found on and near bed-rock. In the deep beds of the ancient "leads" of California this generalization almost invariably holds good. Mr. Augustus J. Bowie, jr.,(a) speaking of these deposits, after quoting several instances in point, remarks:

> Experience has proved that the quantity of gold found in "top-gravel" is insufficient to warrant any large investment based solely on its value. Under exceptional conditions and circumstances the upper strata have in some cases yielded handsome returns, but on the whole the general results have been anything but fortunate. It is therefore a well-established fact that the pay-dirt is obtained not from the washings of the entire bank, but chiefly from that stratum or those strata which are in most cases within 8 or 10 feet of the bed-rock.

It has certainly been shown by the workings of the more important deep placer mines of California, where, indeed, the most of the recorded observations have been made, that the lowest strata are the richest. For mines worked by the hydraulic method this often means a removal of large masses of barren, nearly barren, or unprofitable matter, in order to wash the paying portion, and with banks of great height often demands costly preliminary operations, as tunnels or deep cuts, before the deposit can be bottomed. On the contrary, in mines capped by lava, where drifting is in any event the only mode of working, the concentration of the gold in a thin stratum on the bed-rock is an advantage, as a correspondingly small amount of gravel has to be excavated in order to secure the bulk of the "pay".

In the shallow placers, however, the gold is apt to be more evenly disseminated throughout the deposit, and is sometimes found chiefly at the top. Deeper deposits also occur, containing strata of clay or barren cement false bed-rocks, in which the surface gravel is auriferous, while below the pay and false bed-rock there may be a deep body of "dead wash".

In river beds the gold, instead of settling in the deeper pools, is found chiefly on the bars, but pockets also form in crevices of the bed. The bed-rock itself, especially if decomposed and porous or of upturned slates, often contains gold to a depth of 2 or 3 feet. This is the case in many of the old channels, and in those worked by

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a Hydraulic Mining in California, *Transactions of American Institute of American Engineers*, vol. vi, p. 31.

drifting it is commonly the practice to mine the bed-rock to a certain depth, while in hydraulic mines the bed-rock, if auriferous, is piped off according to its softness. As stated, hollows and crevices in the bed are usually the richest spots; but there is sometimes an exception to this in the case of large and deep pot-holes, which are found to be filled with barren wash, while the pay stratum continues uniform above them. It has been observed in some localities that where sand strata or clay seams come in the pay ceases beneath, but such observations can be only of local validity. In many of the wide extinct channels the pay is confined to a comparatively narrow path, usually at the middle and lowest portion.

The gold of the placers is by no means exclusively in the form of grains, scales, nuggets, etc. It is also found attached to its original quartz matrix in varying proportions, from pieces which could almost be termed nuggets, but which have sufficient gangue in them to materially affect their specific gravity, up to quartz bowlders, which contain gold disseminated with the same fineness and occasionally in the same proportion as the average free-gold milling ores from veins, in much of which no gold is ordinarily visible to the eye. The cement mills connected with some drift claims afford a means of partially saving this gold, but in hydraulic mines the fine gold contained in the unexposed portions of quartz gravel and bowlders is lost. Large bowlders have been found of a grade sufficient to warrant their crushing in ordinary gold stamp-mills.

GRASS-ROOT GOLD.—Where the gravel comes to the surface, and, less frequently, where the upper stratum consists of loam containing more or less fine quartz wash, grass-root gold is often found. It is said to be met with more frequently in shallow than in deep placers, but an insufficient number of observations is recorded to admit of a safe generalization. If it occurs in hollows, it is not always an indication that the whole of the upper gravel is to be considered more or less auriferous, for it may have been simply the result of a local secondary wash. The gold found at the surface usually consists of very light, thin scales, not so readily saved as the more granular and heavier particles of the lower strata, but in a few cases quite coarse gold has been detected. It has been suggested that the finely divided metal usually known as "grass-root gold" has been precipitated by vegetable matter from solution in iron salts or other solvents, but it is not certain that any but mechanical influences have affected the distribution of the metal in the gravel deposits.

RUSTY GOLD.—A portion of the placer gold exists in a state such as to render its amalgamation difficult or impossible. Such gold is called by miners "rusty". The cause is supposed to be a coating of silica cemented by sesquioxide of iron, the latter due to the decomposition of pyrite associated with the gold in the original matrix, or, according to another theory, to be a partial oxidation of the base metals alloyed with the gold. Vein gold is also said to exist in a similar condition. In the laboratory this film may be removed by digesting the rusty gold with chlorhydric acid and subsequent rubbing, or by brightening the surface mechanically by filing and scraping, when the refractory gold at once becomes facile. Certain improvements in quartz-crushing machinery aim to do this on the large scale for vein gold, but the attrition in placer washing is insufficient to render the rusty gold wholly susceptible to the influence of quicksilver. Specific gravity, therefore, rather than amalgamation, determines the saving of such of this gold as is caught.

ALLOYS OF PLACER GOLD.—Nearly the whole of the metal alloyed with gold is silver. A little copper and iron also occur in association. In the bullion, after melting, are sometimes found, in addition to these metals, traces of lead, zinc, antimony, arsenic, and tin. Much of the base metal entering into the alloy is undoubtedly due to the concentration of metallic refuse of various kinds in the process of washing. Thus the presence of lead is accounted for by the miners, and probably correctly, by the fact that the shot which may have been fired into a gravel bank by sportsmen are, owing to the high specific gravity, caught by the appliances designed to save the gold. It is stated that, even after careful retorting and melting, minute traces of quicksilver remain in the gold.

MINERALOGY OF THE "WASHINGS".—An enumeration by Professor Silliman of the minerals of the Cherokee Flat washings embraced gold, platinum, iridosmine, diamonds, zircon, topaz, quartz in several varieties, chromite, magnetite, limonite, rutile, pyrite, garnets, epidote, and almadine.

PLATINUM.—This metal occurs much more frequently and in larger quantities than is commonly supposed, as is also possibly the case with other metals of the same group, such as iridosmine, etc. Search is very seldom made for it, and it would be apt to escape the gold-saving appliances, most of which depend upon amalgamation. It is found, if at all, in small grains associated with the black sand in the sluices.

Among the localities in California reported as showing the presence of platinum are the Spring Valley, Magalia, and Morris Ravine mines, in Butte county; the Bunker Hill, Del Norte, and Happy Camp mines, in Del Norte county; the Weed's Point mine, in Yuba county; the Lincoln, Hart & Henry, Oak Grove, Fort Goff creek, and Thompson creek mines, and in the placers on the south fork of the Salmon river, in Siskiyou county; the La Grange mine, in Stanislaus county; and Chapman & Fisher's, the Gribble, Slattery, and Wiltshire mines, in Trinity county. In Colorado traces are found in the Cash Creek placer, in Chaffee county, and in the L. H. Arthur and Edward mines, in Clear Creek county. In Oregon small quantities have been detected at upper Grass creek and Evans creek, in Jackson county, and at Sunken creek, Josephine creek, Silver creek, Galin creek, Desselles & Co.'s, and the Blue Gravel mines, in Josephine county.

The quantities reported as found are very small, being from a fraction of an ounce to a few ounces per clean-up, and in most cases are saved merely as a curiosity. In the absence of systematic tests, it would be premature to predict positively that the saving of platinum is likely to become an important adjunct to the gold placer-mining industry; but it seems reasonable to suppose that such a possibility exists, and that in some of the many localities where platinum is known to occur future experiments may lead to important economic results. With the improvement of appliances designed to save "rusty" gold by specific gravity alone—such, for instance, as a system based on retaining a larger bulk of black sand and other heavy material in the sluices and under-currents and subjecting it to a second treatment by mechanical concentrators—probably larger quantities of platinum will be found.

DIAMONDS.—The occasional occurrence of diamonds in the auriferous gravels of California has long been known, but the finds have thus far been of small importance. In 1864 a diamond valued at $250, from the Spring Valley mine, Butte county, was cut in Boston, and subsequently several were tested in Amsterdam and Paris and pronounced diamonds of the first water, though of small size. In the census year one valued at $80 was found in the same mine. Small diamonds have also been found in the Morris Ravine mine, in the same county. At the Lyon drift mine, at Placerville, El Dorado county, several small diamonds of average brilliancy and not discolored were saved.

The specific gravity of the diamond (3.53) is too low to resist with any certainty the rush of water in the sluices, and of those caught by the riffles few are recognized. It would be well if the men engaged in cleaning up the sluices were to familiarize themselves with the crystallographic and other physical properties of the diamond and its appearance in the native, uncut form; for, as Mr. W. A. Goodyear, of the California state geological survey, wrote in 1871, "though it may not pay to hunt for diamonds, yet it always pays to pick them up when you do happen to see them."

RUBIES AND GARNETS.—At the Bonanza mine, Calaveras county, and the La Grange mine, Stanislaus county, California, both rubies and garnets are reported to have been found. The occurrence of garnets had previously been noted in many of the gravel deposits. It is quite possible that the supposed rubies were also garnets, as it is not known that corundum in any form has been identified by conclusive tests.

STREAM TIN.—Specimens of stream tin have been found in the alluvions of the Middle fork of the Feather river, in Plumas county, California, and in some quantity and widely distributed in the placers of the granitic regions of Idaho, Dakota, and Montana. The ore very frequently escapes recognition, and no systematic search for paying deposits is known to have been made.

INVESTMENT AND OWNERSHIP.

CAPITAL STOCK OF PLACER MINING COMPANIES.—The nominal capital stock of the mining corporations has but little significance. The placer properties are usually capitalized at much less amounts than has been the custom with deep mines, though for no apparent reason, unless, indeed, the fact that the stock of the former is less apt to be found upon the lists of the mining boards and is not so frequently used as a vehicle for speculation. But even thus the nominal capital has often little relation to the amount of money invested or the actual value of the properties. The present Spring Valley Hydraulic Gold Mining Company, for instance, has a nominal capital stock of only $200,000, in 200,000 shares of $1 each, though when placed upon the market the shares brought $10 each. In this case the incorporation was effected under the laws of the state of New York, the purpose of the low capitalization being to insure individual stockholders against any possible personal liability or assessments. Thirty-six placer mining companies reported have a nominal capital of $35,115,000, or an average of $975,417, and the average par value of the shares of $34,815,000 of this amount is $14 68.

There are a large number of claims held by unincorporated companies, each consisting of a few individuals. The ownership of these is often divided into a small number of shares, commonly the same number as that of the original holders, but each share of correspondingly higher value.

CAPITAL ACTUALLY INVESTED IN PLACER MINING.—This cannot be definitely ascertained or even approximately estimated. In the case of the State of California *versus* the Gold Run Mining Company the statement was made that the capital invested in mining in California is about $160,000,000, of which $100,000,000 is in gravel mining. Referring to this testimony Lieutenant-Colonel Mendell (*a*) remarks:

> This appears to be a generalized opinion, based upon a partial knowledge of investments. It is not based upon detailed information, and is not claimed to be more than an approximation. So far as it applies to gravel mining, the amount is probably in excess. Perhaps it is quite as well for the purposes of this report to be able to say that invested capital is large as to be able to give the specific amount. This kind of information for a majority of mining properties is quite out of the question.

For the following-named companies Lieutenant-Colonel Mendell (*b*) gives the several amounts, including in each case presumably the cost of ditches, reservoirs, etc.:

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a Mining Débris in California Rivers, p. 17. *b Mining Débris in California Rivers*, p. 18.

TABLE LXIII.—CAPITAL INVESTED IN LEADING HYDRAULIC MINES.

Name of company.	Amount.
Total	$15,262,494 77
Excelsior, of Smartsville	2,207,186 33
North Bloomfield and Milton	4,079,321 49
Gold Run	425,326 69
Blue Tent	755,000 00
El Dorado Deep Gravel	1,000,611 26
Eureka Lake (approximate)	2,500,000 00
South Yuba	2,000,000 00
Spring Valley	2,000,000 00
La Grange (about)	650,000 00

WORKING CAPITAL.—Returns from only 10 hydraulic mines, giving amount of working capital, were received. The total for these few reporting mines is stated at $1,495,000.

LOCALITY OF OWNERSHIP.—Of the placer mines reported upon with reference to ownership, 88 per cent. are held in the state or territory where they are located and 12 per cent. are controlled by capital from other parts of the country. Nearly one-half of the investments in placer property by capitalists living in non-mining states have been made in New York city. The accompanying table shows the manner in which the ownership of the more important placer mines is distributed:

TABLE LXIV.—LOCALITY OF OWNERSHIP OF PLACER MINES.

State or territory in which mines are located.	Total number of mines with ownership specified.	Owned in state or territory where located.	Owned in other states or territories than those in which the mines are located.												
			Total.	California.	District of Columbia.	Illinois.	Indiana.	Massachusetts.	Minnesota.	Missouri.	New Hampshire.	New Mexico.	New York.	Ohio.	Pennsylvania.
Total	227	200	28	8	1	2	2	2	1	1	1	1	11	1	8
Arizona	2	1	1									1			
California	112	105	7				2	1			1		2		
Colorado	11	7	4			1		1		1			1		
Dakota	10	7	3						1				2		
Georgia	11	4	7			1							4	1	1
Idaho	7	7													
Montana	14	14													
North Carolina	3	1	2		1										1
Oregon	65	62	3	3											
South Carolina	1	1													
Utah	1		1										1		

EXTENT OF CLAIMS.—The river bar claims of the first years of placer mining, which were worked by single miners or small parties, were often but 20 feet in length and of the same width as the channel. This, in some districts where the virgin ground was very rich, was the recognized extent of a location, though in others the unit was somewhat greater, and in certain localities reached 200 or 300 feet, measured on the length of the deposit. (a) Occasionally the ground was located in square areas, as, for instance, in plots 100 by 100 feet. Great differences existed in the local regulations of the various camps, though the tendency in all was to keep the size of individual claims within narrow limits; but the extensive equipment and development of a modern hydraulic mine of importance demands a large area of workable gravel, in order to offset the preliminary expenses and give the mine any permanence. When it is considered that a single company, by means of the powerful hydraulic rig of to-day, may wash upward of 3,000,000 cubic yards of gravel in a single season, (b) it will be seen that to insure continuity of work considerable extent is necessary. Even with deep banks the acres melt away rapidly before the hydraulic nozzles.

a The shallow placers near Bodie, Mono county, California, worked on a small scale during the census year, are by the local regulations held as follows: (A) Flat claims, 250 feet square; (B) hill-side claims, 200 feet front, extending back to the summit of the hill; (C) gulch claims, 50 feet each side of run of water.

b The North Bloomfield Gravel Mining Company, No. 8 claim, in a run of 342 days in 1876, washed 2,912,700 cubic yards. The bank was 260 feet deep.

Many of the more important mines in California comprise tracts of over 500 acres each. The Spring Valley, 1,215 acres, and Morris Ravine, 1,300 acres, in Butte county; Happy Camp, 507 acres, in Del Norte county; Liberty Hill, 554½ acres, and North Bloomfield, 1,585 acres, in Nevada county; Gold Run, 500 acres, in Placer county; North Fork, 800 acres, and Plumas, 1,355 acres, in Plumas county; Dry Creek, 1,332 acres, in Shasta county; La Grange, 1,200 acres, in Stanislaus county; Buckeye, 1,700 acres, Lewiston, 640 acres, Weaver Creek, 600 acres, in Trinity county; and the Golden Rock, 640 acres, in Tuolumne county, are examples of mines of this class. A still larger number are between 200 and 500 acres in size. In Colorado, Idaho, and Dakota the ground is held in large blocks. One mine, the Castle Creek, in Pennington county, Dakota, consists of 88 claims of 300 feet each in length, with a width equal to that of the deposit.

Some of the drift mines of Sierra county, California, are of great extent. The Bald Mountain mine embraces 7,500 linear feet of the channel, of which 4,000 feet have been worked; the Union, 2,400 feet; Hawkeye, 800 feet; Pittsburgh, 860 feet; Monumental, 1,040 feet; and Empire, 1,560 feet. Mr. W. A. Skidmore states that the working life of a mine of this class has a duration of from ten to twenty years, according to length of its location on the channel.

In working river beds by the dam and fluming method it is necessary to drain considerable lengths of the streams to render the enterprise profitable. Dams and tunnels or flumes are sometimes so favorably located as to lay bare the river beds for miles.

NATURE OF TITLE.—In the early history of placer camps the claims, as is the case with quartz veins, are first held by virtue of location or discovery. This constitutes what is called a "miner's title". In the next stage there is a large proportion of consolidated ownership still resting upon the original "miner's title", the property being acquired by purchase of individual locations. Finally, the large and valuable tracts of auriferous ground which are worked by corporate capital or by strong firms are often for greater security covered by United States patents. The trouble and expense incurred in procuring a patent usually prevent the original locators from thus securing their title, and it is generally not until the ground has changed hands at least once that the patent is applied for. As the mines reported upon are properties developed to a considerable extent, the proportion patented is much larger than would be the case if all the placer mines, large and small together, the newly-discovered and the long-worked, were considered. Table LXV, therefore, represents only the nature of the titles of the more important mines.

TABLE LXV.—PLACER MINES—NATURE OF TITLE.

Nature of title.	Total, according to nature of title.	Arizona.	California.	Colorado.	Dakota.	Georgia.	Idaho.	Montana.	North Carolina.	Oregon.	South Carolina.	Utah.
Total by States and Territories	204	2	85	11	11	10	7	14	3	59	1	1
Patented	40	.....	26	4	.....	.....	.....	6	.....	4	.....	.....
Partly patented	17	.....	10	3	.....	.....	.....	1	.....	3	.....	.....
Patent applied for	11	.....	6	1	1	.....	.....	.....	.....	3	.....	.....
Location or discovery	29	2	5	1	1	.....	.....	3	.....	17	.....	.....
Purchase or part purchased	43	.....	10	.....	1	.....	5	.....	.....	25	.....	1
Quit-claim deed	1	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Warrantee deed	2	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....
Fee-simple	10	.....	.....	.....	.....	7	.....	.....	2	.....	1	.....
Lease	1	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Unspecified	51	.....	28	1	8	1	2	4	.....	7	.....	.....

PROPERTY OWNED IN CONNECTION WITH PLACER MINES.—In the case of mines worked by the hydraulic method this may embrace (in addition to the mining claims) water rights, ditches, flumes, pipes, reservoirs, etc.; office, shops, and buildings for lodging the men and storing tools and material; the working plant of the mine, such as feed pipes, distributers, nozzles, derricks, sluices, and tools; supplies, such as quicksilver, iron, steel, lumber, powder, fuse, etc.; horses, wagons, barns, and feed; right of way for tailings, or land held for the dump, sometimes including brush and earth dams for impounding the tailings. The Spring Valley Company owns and operates a telegraph line from Cherokee to Oroville, 12 miles, with complete outfit. A saw-mill, for furnishing lumber used in sluices, flumes, etc., is occasionally an adjunct. Altogether, the equipment of a large hydraulic mine involves a very considerable outlay beyond the simple ownership of mining ground. Drift mines yielding cement gravel sometimes are equipped with stamp batteries for coarsely crushing the cement before sluicing it.

TECHNICAL METHODS EMPLOYED.

HYDRAULIC MINING.

ORIGIN OF HYDRAULIC MINING.—From the rediscovery of gold in California in 1848 the primitive pan, rocker, long-tom, and short sluice were the appliances used in earth washings up to the spring of 1852, when a miner, whose name is not remembered, introduced the first hydraulic apparatus(*a*) at his claim at Yankee Jim, Placer county, California. Mr. Waldeyer says:

> This machine was very simple. From a small ditch on the hill-side a flume was built toward the ravine, where the mine was opened; the flume gained height above the ground as the ravine was approached, until finally a "head" or vertical height of 40 feet was reached. At this point the water was discharged into a barrel, from the bottom of which depended a hose, about 6 inches in diameter, made of common cowhide, and ending in a tin tube about 4 feet long, the latter tapering down to a final opening or nozzle of 1 inch. This was the first hydraulic apparatus in California, simple in design, dwarfish in size, yet destined to grow out of its insignificance into a giant powerful enough to move mountains from their foundations. The news spread among the miners, the wonderful practicability of the new invention was at once acknowledged, and, wherever circumstances permitted, a "hydraulic", the name adopted for the novel apparatus, was "rigged".

THE DUMP.—Without the means of getting rid of the tailings the hydraulic miner is helpless. The possession of "pay gravel" and water are not alone sufficient. A place must be provided at a lower grade for the vast masses which are moved from their original position. These, after being broken up, occupy more space than when in the bank. After the natural dump-room is exhausted by choking, and the sluices have been extended as far as the grade will permit, then resort is had to tunneling. Some placers, indeed, especially those in ancient channels bounded by rim-rock higher than the bottom of the gravel, can only be opened in the first instance by expensive open cuts or by long tunnels, in such a manner that the lowest or richest portion may be made available. To secure a proper dump is often a matter of greater difficulty than to bring water upon the ground.

TUNNELS AND CUTS.—Very long tunnels or cuts are often required to open deep placers to the bed-rock, and with some mines the preliminary work necessary to thus bottom the claim forms the chief item of expense. The open cuts, if in moderately loose earth, are sometimes made by the use of the hydraulic nozzle, which is an efficient and cheap means of excavation if the conditions are favorable. If the cuts are made in rock, blasting is resorted to. The operation of driving the long bed-rock tunnels is prosecuted as in vein-mining. The ground is, however, apt to be softer than the average country rock of vein mines, allowing more rapid progress; but more careful timbering is, for the same reason, usually required. The grade of these tunnels being adapted to the sluicing of heavy material, is necessarily much steeper than would suffice for simple drainage.

By far the majority of hydraulic mines are opened by cuts alone. About one-fifth of the mines reported on have tunnels, and of the latter class several have auxiliary cuts in addition to the tunnels.

In planning a tunnel designed to open a gravel channel great care is necessary to locate it at such a depth that its face at the middle or lowest part of the channel shall remain in bed-rock, and to provide against inequalities in the surface of the bed-rock it is usual to allow a considerable margin in depth, ranging from 40 to 75 feet below the top of the bed-rock at the point of connection by chimney. Careful surveys are therefore first made and liberal allowance is made for irregularities, in order that all of the deposit may be bottomed. A want of care in this respect has caused heavy loss in several instances, the money spent in driving the tunnel being thrown away if by bad calculation the latter has been run out of grade.

Some examples of tunnels in placer mines are given in the accompanying list.

TABLE LXVI.—TUNNELS IN PLACER MINES.

CALIFORNIA.

Name.	Locality.	Length.	Width.	Height.	Average grade.
		Feet.	*Feet.*	*Feet.*	*Feet per 100.*
American	Below San Juan	3,000			6.25
Babb	Timbuctoo	1,200			3.00
Bed-Rock	Below Sweetland	2,000			3.25
Blue Gravel	Sucker Flat	1,100			4.50
Blue Point	do	2,250			4.16
Bonanza	Mokelumne Hill	200	4	6	6.25
Boston	Wolsey's Flat	1,000			7.25
Buckeye	Buckeye district	1,200	7	7½	
Deer Creek	Mooney's Flat	2,200			3.40
Del Norte	Del Norte county	600	3	6	5.50
Dry Creek	Ione	300			2.75
Duryea	Mokelumne Hill	200	6	4½	5.66
English Mine	Badger Hill	1,400			7.00
Enterprise	Sucker Flat	1,200			4.16
Evans & Bartlett	Red Hill	300			4.17

(*a*) Paper on Hydraulic Mining in California, by Mr. Charles Waldeyer, in *Report of Mining Commissioner*, 1872, p. 390.

TABLE LXVI.—TUNNELS IN PLACER MINES—Continued.

CALIFORNIA—Continued.

Name.	Locality.	Length.	Width.	Height.	Average grade.
		Feet.	Feet.	Feet.	Feet per 100.
Farrel	Columbia Hill	2,200			3.50
French Corral	French Corral	3,500			4.08
Gold Run	Gold Run	2,500			4.08
Hidden Treasure	Michigan Bluff	2,700	10	12	4.02
La Grange	La Grange	2,700	6½	5	1.33
		a 1,300	6½	4	2.02
Lyon Gravel (b)	Placerville				
Mammoth	Red Hill	1,300	6	5	1.64
Manzanita	Sweetland	300	5	6	6.25
North Bloomfield	Humbug Cañon	1,740			4.16
Orion	Iowa Hill	3,000			4.50
		600	8	8	5.56
Pactolus	Timbuctoo				
Paragon (b)	Bath	1,700			4.16
Penobscot	Mokelumne Hill	2,000	5½	5 to 6	1.64
Pittsburgh	Sucker Flat	200	3	6½	6.30
Polar Star	Dutch Flat	900			4.16
		600	9	9	6.94
Rose's Bar	Timbuctoo				
Spring Valley	Cherokee Flat	1,600			4.16
Do	do	1,400	6	6½	2.01 to 4.02
Sunnyside	Seneca	400	6	6½	2.01 to 4.02
Sweetland Creek	Sweetland	750	5	6½	6.61
		2,200			4.66
Van Emmons	Michigan Bluff				
Weed's Point	Galena Hill	c 1,200	4½	8	3.02
		600	4 to 5½	6	4.51
COLORADO.					
L. H. Arthur	Grass Valley district	330	4	5	Level.
Do	do	400	4	5	Level.
Rob Roy	Spaulding district	50	5 to 6	4	6.42
Do	do	67	5 to 6	4	6.42
DAKOTA.					
Castle Creek (b)	Cañon district	550	10	12	2.43
Fort Meade	Ruby district	6.5	10	12	2.43
Last Chance Bar (b)	Cañon district	1,800	4	5	
McKay & Ross	Cape Horn district	200	5	7	4.02
GEORGIA.					
Findley	Lumpkin county	270	4	6	
Griscom	do	600	6½	6	8.33
MONTANA.					
Charles Pryse (b)	McClellan Gulch	1 mile	5	5	6.61
OREGON.					
Blue Gravel	Yank district	200	8	10	6.25

a Five. b Drift mines. c Two.

CHIMNEYS.—These are connections between the tunnel and the surface, and are usually made by raising from the tunnel, though sometimes the tunnel is driven to connect with a prospecting shaft, in which case the latter becomes the working chimney. The proper location for the chimney is at the point where the bed-rock is lowest, or near the middle of the channel. When all the ground controlled by one chimney has been worked off, it sometimes is possible to extend the tunnel and open a new chimney, thus developing a further territory.

As regards the form of the chimney a diversity of practice exists. More commonly it is a vertical opening, the gravel being dropped upon a rock pavement in a single fall. Some engineers prefer a chimney built in steps, which break the fall, and from the lowest step, which is shallower than the others, the wash flows directly into the head of the sluice. A third variety is a simple inclined chute.

In making an upraise from the tunnel through the gravel precaution is taken against a rush of water and quicksand, which is liable to occur when the channel is tapped, and the timbering needs to be substantial. As the surface about the mouth of the chimney is washed away the timbers are removed, set by set, until a permanent level has been reached, and the wash from the face of the bank is led to the chimney by shallow cuts. Careful watching is also required in the first washings to prevent choking, as the work of clearing away an accumulation of this kind from below is difficult and dangerous.

POWER DRILLS.—Excavations in the gravel itself are usually made without difficulty, except as regards timbering. Sometimes, however, power drills, such as the Burleigh or the Ingersoll, driven by compressed air, are employed in making cuts or in tunneling, and greatly expedite matters.

BLASTING.—In tunneling, the mode of blasting is similar to that in vogue in vein-mining. The explosive, commonly a nitro-glycerine powder (Giant, Hercules, or Vulcan) of No. 2 grade, is tamped in drill holes and fired by caps and time-fuse. To break up large bowlders holes are drilled and from one-half a stick to two sticks of a nitro-glycerine powder is fired in the usual way. A stump is destroyed by boring a hole and exploding in it a part of a cartridge. Small quantities of the high explosives are also used in breaking up patches of cement, as required.

Bank-blasting on the large scale is an operation requiring judgment and experience on the part of the hydraulic miner. The conditions, such as height of bank and tenacity of ground, vary so greatly that the quantities of powder used and the precise method of disposing it are matters for calculation in particular cases rather than subject to any general rule. An inquiry addressed to superintendents to ascertain the average amount of ground loosened per unit (100 pounds of black powder) developed such a wide range of experience or of opinion that no useful result would be gained by particularizing the replies. The subject is worthy of more careful investigation than has yet been made, and it would be well if the details connected with the use of heavy charges in gravel were always published in full.

A slow-burning explosive, such as black or Judson powder, is found to give the best results in bank-blasting. As regards quantity, it is usual to allow a liberal margin above the amount theoretically sufficient, for the additional expense is of less importance than would be a failure of the blast. The usual method of disposing the powder is to run a small and short drift into the bank at or near bed-rock, and from it two cross-drifts parallel to the face of the bank, in the form of a simple T. The powder is placed in the cross-drifts, and after charging and laying the wire connections the main drift is tamped. Sometimes a more complicated system of cross-drifts is adopted, and short galleries, called "lifters", are also added, being driven from the extremities and center of the cross-drifts toward the face of the bank. These modifications are used where the bank is not very deep. The bank-blasts are usually exploded by a frictional electrical apparatus.

In blasting extremely high banks, instead of attempting to shatter the whole mass from the bottom upward by direct action of the explosive, cross-drifts are driven parallel with the face of the bank, and at such distance that the strip of ground between them and the face can be blown out, thus allowing the upper part of the bank to fall by its own weight. Very large blasts have been fired in some of the gravel mines of California. At the Spring Valley mine the blasts range up to 25,000 pounds of black powder. At the Blue Point mine a blast of 2,000 kegs (50,000 pounds) of powder was fired, and a charge of 1,700 kegs was exploded in the Enterprise mine. Bank-blasting not only facilitates the work of the nozzles and renders it possible to "hydraulic" tough ground, which would be otherwise piped off with difficulty or even altogether unworkable, by breaking up the cement, pipe-clay, etc., but it also serves the very important purpose of disintegrating the gravel and freeing the gold particles. The more thoroughly the ground is shattered the better its condition for sluicing. In blasting bottom cement and bed-rock the powder is disposed in a system of small transverse galleries, or in single charges in bottle-shaped excavations, the necks of which are tamped with earth.

Most hydraulic mines, including those which do not need regular bank-blasting, consume at times small quantities of high explosives, which are conveniently used in wet ground and require little care in tamping. The total amount of powder thus absorbed is considerable, but for individual mines this item of expense is generally not a heavy one. In mines where bank-blasting on the large scale is practiced the cost of explosives, on the contrary, is a leading consideration, taken in connection with the labor and loss of time involved in preparing for each blast.

FEED PIPES.—The pipes conveying the water from the pressure-box to the distributer and nozzles are made of wrought iron if the fall is considerable, though doubled or three-ply canvas hose, if carefully made, can be used advantageously with small volumes of water at pressures of 75 feet, and is sometimes employed with still greater fall. The iron pipe is made in lengths, the longitudinal seams are riveted, and the joints connected by simple insertion, by lugs and wire or by riveting. The upper end of the pipe connects with the pressure-box by means of a tapering, funnel-shaped section of sheet iron. The permanent pipes are supplied with air-valves, and are braced with frame-work and weighted to prevent shifting. The aggregate length of such pipes in use is certainly not less than the total extent of the piping on ditch lines; and though no figures are at hand for an accurate estimate, there are probably in the neighborhood of 200 miles of feed pipes in the hydraulic mines.

The pressure of water used varies greatly in different mines, ranging from very moderate falls to heads of upward of 400 feet, according to the elevation at which water can be brought upon the ground and the capacity of the rig. The variations in this respect, and the dimensions of feed pipes on some of the hydraulic mines, are shown in the accompanying list, to which is appended for reference a table of the thickness and weight per square foot of wrought iron of the numbers commonly used, according to United States and Birmingham gauges.

TABLE LXVII.—FEED PIPES IN HYDRAULIC MINES.

ARIZONA.

County and district.	Mine.	Head pressure.	No. in use.	Length.	Diameter.	Thickness.
YAVAPAI.		*Feet.*		*Feet.*	*Inches.*	
.....	Jackson	.....	1	.....	.....	

CALIFORNIA.

BUTTE.						
Cherokee Flat	Spring Valley	311	3	.....	15 and 22	$\frac{1}{16}$ $\frac{1}{12}$ $\frac{1}{8}$ inches.
Morris Ravine	Morris Ravine	160	2	.....	11 and 22	No. 14.
Oroville	Oroville	35	6	.....	One, 30 Five, 14	Main $\frac{1}{4}$ inch. Small $\frac{1}{16}$ inch.
CALAVERAS.						
Mokelumne Hill	Bonanza	100	1	.....	11	No. 14 and 16, United States gauge.
Do	Duryea	.....	.....	.....	11	No. 14 and 16, United States gauge.
Do	Eureka	400	2	.....	11 and 13	No. 14 and 16, United States gauge.
Do	Mammoth	130	.....	.....	11	No. 16, Birmingham gauge.
Do	Penobscot	250	.....	.....	11	No. 16, Birmingham gauge.
DEL NORTE.						
.....	Bunker Hill	240	.....	2,200	11	No. 16.
.....	China Creek	226	2	2,680	11 and 15	No. 16.
.....	Del Norte	160 to 175	3	4,000	11, 15, and 19	No. 16.
.....	Happy Camp	125 to 200	2	3,100	11 to 24	No. 16.
.....	Muc-a-muc	90	1	1,160	11 to 15	No. 16.
.....	Wingate	260	1	1,200	15	No. 16.
PLACER.						
Dutch Flat	Polar Star	450	3	.....	Tapering from 4 feet to 11 inches.	No. 14 and 16.
Gold Run	Gold Run	400	3	.....	Tapering from 5 feet to 16 inches.	No. 14, Birmingham gauge.
Iowa Hill	Orion	440	1	.....	15 to 22	Nos. 18 to 12.
Michigan Bluff	Van Emmons	200	3	.....	11	Nos. 18 to 16, Birmingham gauge.
PLUMAS.						
Seneca	North Fork	75	1	.....	16	$\frac{1}{4}$ inch.
.....	Black Hawk	50	1	.....	11	$\frac{1}{16}$ inch.
.....	Hungarian Hill	100	4	.....	15 and 22	$\frac{1}{4}$ and $\frac{1}{8}$ inch.
.....	Plumas M. and W. Co	350	5	.....	15 and 22	Nos. 16, 14, 12.
SHASTA.						
Igo	Dry Creek	175	.....	8,800	15, 19, and 30	$\frac{1}{16}$ inch.
SISKIYOU.						
Callahan's Ranch	A. B. C. (a)	175	7	1,200	.....	Nos. 18, 20, 22.
Indian Creek	Bay City	200 to 300	1	1,000	8	No. 20.
Do	Coyote Gulch (a)	184	2	900	6	No. 18.
McAdams Creek	Hiyou	150 to 200	1	800	6	No. 20.
Do	Oak Grove	.....	1	.....	7	No. 16.
Oro Fino	John Young	200	1	2,000	6	Nos. 20 and 24.
Scad Valley	Fort Goff Creek	275	1	800	11 to 15	No. 18.
Do	Thompson Creek	65	1	800	15	No. 16.
STANISLAUS.						
La Grange	La Grange	20 to 125	.....	.....	Main, 22; others, 15 to 36	
TRINITY.						
Buckeye	Buckeye	300	.....	2,673	11 to 15	
Cabon Creek	Berger	.....	.....	1,500	9 and 11	
Do	Wilt	.....	.....	1,500	9 and 11	
Douglas	Smith's Flat	.....	.....	2,000	20	No. 16.
Indian Creek	Johnston	200	.....	2,700	15 and 22	
Junction City	Lewiston	175 and 275	.....	1,800	13 and 15	No. 18.
Minersville	Digger Creek	.....	.....	900	11 and 13	
Red Hill	Evans & Bartlett	.....	.....	2,000	11	No. 18.
Do	Mammoth	160	.....	1,700	15 and 22	Nos. 14 and 16.
Do	McKenna	200	.....	2,100	7 and 15	No. 16.
Taylor's Flat	Trinity	.....	.....	700	15	Nos. 14 and 16.
Weaver	Garden Gulch	.....	.....	2,000	15	
Do	Harvey Bros	230	.....	1,900	13 and 15	Nos. 16 and 18.
Do	Holman & Mahon	.....	.....	2,100	15, 16, and 18	
Do	Hupp & Murry	210	.....	2,400	13 and 15	Nos. 16 and 18.
Do	Mabie's Bench	.....	.....	1,350	6, 7, and 15	
Do	Rule Bros	100	.....	1,200	13	Nos. 16 and 18.
Do	Weaver Creek	.....	.....	600	15	
.....	Center Placer	250	.....	1,400	13	No. 16.
.....	Chapman & Fisher	.....	.....	3,000	15	No. 16.
.....	Gribble	.....	.....	2,000	7 and 11	
.....	Hager & Haas	.....	.....	1,500	14	
.....	Slattery	.....	.....	700	15 and 18	No. 16.
.....	Trinity	270	.....	4,500	15	Nos. 14 and 16.
.....	Wiltshire	.....	.....	1,600	13 and 15	
YUBA.						
Galena Hill	Weed's Point	95	2	.....	11 to 15	Nos. 16 and 18.

a Galvanized sheet iron.

TABLE LXVII.—FEED PIPES IN HYDRAULIC MINES—Continued.

COLORADO.

County and district.	Mine.	Head pressure.	No. in use.	Length.	Diameter.	Thickness.
CLEAR CREEK.		*Feet.*		*Feet.*	*Inches.*	
Grass Valley	L. H. Arthur (a)	60			6	¼-inch.
Jackson	Edward	60	1		6 to 24	No. 16.
LAKE.						
California	Oro M. D. and F. Co	140			6 to 30	No. 14.
LA PLATA.						
California	Parrot City	75		1,200	12 to 20	¼-inch.
PARK.						
Alma township	Alma	80	3		16 to 22	No. 20.
ROUTT.						
Hahn's Peak	Hahn's Peak	235	1		15	⅛-inch.
SUMMIT.						
Spaulding	Rob Roy	85			16	
Do	Slaler	75			7 to 16	⅛-inch.

DAKOTA.

PENNINGTON.						
Confederate	Stockade (a)	25			6	
Rockerville	Black Hills Placer Company	200			9 to 22	½- and ¾-inch.

GEORGIA.

HALL.						
810 G. M	Glade (b)	156		900	6	¼-inch.
LUMPKIN.						
Twelfth	Battle Branch	130	1		9	No. 16, wire-gauge.
Do	Findley (b)		1		4	No. 16, wire-gauge.
Do	Griscom		1		4	No. 16, wire-gauge.
Twelfth and First	Chicago and Georgia	80			6	No. 24, wire-gauge.
Do	Hand and Barlow	75	1		9	
Thirteenth	Cleveland, or Bugg's Branch	165	1	520	6 to 16	
		50	1		4	⅛-inch.
UNION.						
Tenth and First	Cocsa (c)	110	1		6	
WHITE.						
Third	Nacoochee (a)	40	2		6	¼-inch.
Fourth	Forest Spring	60	1		6	

IDAHO.

ALTURAS.						
Elk Creek	Hardscrabble (b)	75 to 125	1		7	
BOISÉ.						
Boston	R. W. Spencer	70	2	1,240	6 to 8	
Moore's Creek	Crepiscalia (b)	60 to 100			6	
Do	Noble, Lower & Mann	114		920	7 to 11	
Do	Thorn Creek	75 to 100	2		7	Nos. 18 and 20.
Pioneer	Hon. Ben. Wilson	70		7,000	7 and 11	Nos. 18 and 20.
Do	Stevenson & Noble	150 and 200			11 to 20	Nos. 16 and 18.

MONTANA.

BEAVER HEAD.						
Bannock	Bannock (b)	40			6	¼ inch.
Do	White Bar (b)	20 to 75			6	¼ inch.
DEER LODGE.						
Gold Hill	Squaw Gulch	130	4		11 and 13	⅛ inch.
Henderson Gulch	Butler & Anderson	125	1		6	⅛ inch.
Independence	Oro Fino	60	1	1,300	6 and 7	Nos. 18 and 20.
Nelson	Pioneer (a)	110 to 150	1		6	⅛ inch.
Summit Valley	Noyes & Upton	50	1		6	No. 20.
LEWIS AND CLARKE.						
Last Chance	W. A. Cheesman (a)	45 to 60	4		2 to 6	Nos. 22 and 24.
MEAGHER.						
German	Diamond Flume and Hydraulic	200	1		11	⅛ inch.
Thompson Gulch	California	60 to 75	1		6	⅛ inch.
Do	Morgan Bar	60	1		7	⅛ inch.
Do	Tubbs & Ramsey	75	1		6	⅛ inch.

a Canvas. b Galvanized sheet iron. c Rubber.

TABLE LXVII.—FEED PIPES IN HYDRAULIC MINES—Continued.

NORTH CAROLINA.

County and district.	Mine.	Head pressure.	No. in use.	Length.	Diameter.	Thickness.
MONTGOMERY.		*Feet.*		*Feet.*	*Inches.*	
Eldorado	Beaver Dam	25	1		5	¼ inch.
	San Christian (a)	40	3		3	
POLK.						
	Cochrane	80	1		5	No. 20, Birmingham gauge.

OREGON.

BAKER.						
Blue Cañon	Littlefield & Duckworth	60	1		6	7/32 inch.
Do	Marysville	60	1		13	7/32 inch.
Chicken Creek	J. N. Osborne & Co (b)	60	1		7	7/32 inch.
Do	Porter (b)	60	1		7	7/32 inch.
Humboldt Basin	Colt & Co	60, 80 & 175	3		7	No. 20.
Mormon Basin	Rogers & Copeland	70	1		7	7/32 inch.
Pocahontas	Baisly	300	1		11	7/32 inch.
Do	Baisly & Daly	300	1		11	7/32 inch.
Do	Lew Cooper & Co	130	1		6	7/32 inch.
Do	Neversweat	123	1		6	7/32 inch.
Do	Salmon Creek	300	2		11 and 13	Nos. 18 and 16.
Rye Valley	Powers & Co	90, 100 & 140	5		8	7/32 inch.
Shasta	Ah Moon	100			6	7/32 inch.
Do	Campbell	146		600	8	No. 20.
Do	Steiger's French Gulch	100	1		7	7/32 inch.
Do	Stephenson	65	1		6	No. 20.
Sumter	Sumter	75				
Willow Creek	W. Boswell	70	1		7 to 9	7/32 inch.
DOUGLAS.						
Big Bend Cow Creek	J. Fuller	200		700	11	¼ inch.
Do	D. A. Levens	120		300	7 to 11	7/32 inch.
Do	Merriam & Anderson	160	1	1,400	7 to 10	7/32 inch.
Do	Salmon	175		1,600	15	No. 16.
Cañonville	Catchings	45	1		11	No. 18.
Do	McWilliams & Ash	100	1	800	11	¼ inch.
Green Mountain	Chas. Dwelley	200	1	300	5	7/32 inch.
Do	M. T. Dyer & Son	125	2	750	5 and 7	7/32 inch.
GRANT.						
Cañon City	Sproul (b)	75	1		7	¼ inch.
Granite	Borne & Lucas (b)	45	1		7	7/32 inch.
Do	Kopp & Johnson	130	1		13	7/32 inch.
Marysville	Cannon & Co	200	1		11	7/32 inch.
Do	Thompson	140 to 230	2		11	7/32 inch.
Rock Creek	Erickson Owens	150	1		7	
Do	Lasswell & Co	200	1		7	
Trail Creek	Trail Creek	130	1		13	7/32 inch.
JACKSON.						
Applegate	Grand Applegate	130	1		15	7/32 inch.
Do	Squaw Lake	327	1	1,900	15 to 22	7/32 inch.
Ashland	Anderson & McCall	60	1		11	7/32 inch.
Coyote Creek	Marshall's (b)	40		300	8	¼ inch.
Do	Wm. Ruble	200		700	11	¼ inch.
Farris Gulch	Farris Gulch	300	2	1,200	7	¼ inch.
Forty-nine	Davenport	100		1,120	11 to 22	¼ inch.
Do	Forty-nine	150		1,100	6 to 10	¼ inch.
Sam's Valley	Hays & McGruder	80	1	500	11	No. 16.
Sterling	Saltmarsh	80	1		6	No. 20.
Do	Sterling	330	2		16 and 22	¼ inch.
Uniontown	Chapel & Co	300	1		15	No. 16.
Do	Gin Lin	250	2		15	¼ inch.
Wolf Creek	Gross Bros	100	1	600	11	¼ inch.
JOSEPHINE.						
Grass Creek	Goff, Triplett & Chapin	150	1	630	7 to 11	¼ inch.
Do	Steam Beer	150	1	1,400	11	¼ inch.
Waldo	Deseelles & Co	300	2	2,800	6 to 11	Nos. 16 and 18.
Do	Waldo	150	1	900	13 to 22	¼ inch.
Yank	Blue Gravel	100	3	1,050	16	No. 16.
Do	Josephine	180	2	1,500	11	No. 16.
WASCO.						
Ochoco	Wickaiser & Co	50 to 200	2		6	No. 20.

SOUTH CAROLINA.

CHESTERFIELD.						
	Brewer (c)	65	2	1,700	5	No. 22.

UTAH.

SALT LAKE.						
West Mountain	Argonaut	100			10	¼ inch.

a Rubber. b Canvas. c Galvanized sheet iron.

TABLE LXVIII.—THICKNESS AND WEIGHT OF WROUGHT IRON.

[United States gauge and Birmingham gauge compared.]

UNITED STATES GAUGE.			BIRMINGHAM GAUGE.		
No. of gauge.	Thickness.	Weight per square foot.	No. of gauge.	Thickness.	Weight per square foot.
	Inch.	*Pounds.*		*Inch.*	*Pounds.*
10.....	0.101890	4.0884	10.....	0.134	5.3767
11.....	0.090742	3.6410	11.....	0.120	4.8159
12.....	0.080808	3.2424	12.....	0.109	4.3736
13.....	0.071961	2.8874	13.....	0.095	3.8119
14.....	0.064084	2.5714	14.....	0.083	3.3304
15.....	0.057068	2.2899	15.....	0.072	2.8890
16.....	0.050820	2.0392	16.....	0.065	2.6081
17.....	0.045257	1.8159	17.....	0.058	2.3272
18.....	0.040303	1.6172	18.....	0.049	1.9661
19.....	0.035890	1.4400	19.....	0.042	1.6852
20.....	0.031961	1.2824	20.....	0.035	1.4044
21.....	0.028462	1.1420	21.....	0.032	1.2840
22.....	0.025347	1.0170	22.....	0.028	1.1235
23.....	0.022571	0.9057	23.....	0.025	1.0031
24.....	0.020100	0.8065	24.....	0.022	0.8827
25.....	0.017900	0.7182	25.....	0.020	0.8025

NOZZLES.—The size and power of hydraulic nozzles have steadily increased from their first introduction, and with the higher heads of water larger apertures have come into use. Thus, while a few years ago an 8-inch nozzle was the largest size employed, and then only in a very few mines, machines throwing streams up to 11 inches in diameter have since been introduced, with the probabilities of a still greater increase.

The number of nozzles in use upon a claim varies from one to fifteen. It is very frequently the practice to direct two streams upon a single point of the bank, thus obtaining a cross-fire. At most of the larger mines work is prosecuted at several different parts of the claim, and, as some companies operate several scattered claims, a number of nozzles are often employed by a single ownership.

The larger hydraulic nozzles of the "Little Giant" type are deflected by levers and counterpoised. The small brass hand nozzles, of no particular pattern, ranging from 1½ to 4 inches in diameter, are conveniently slung from a movable tripod and directed by hand. Such nozzles are usually connected by a tapering galvanized iron sleeve to a length of canvas hose and have no joints.

The number and the sizes of nozzles used at some of the hydraulic mines are given in the accompanying table. The heads or pressures of water, in feet, are stated in Table LXVII.

TABLE LXIX.—HYDRAULIC NOZZLES.

County and district.	Mine.	No. of nozzles.	No. fed by one pipe.	Size.	Mean length of stream.
YAVAPAI.					
.....	Jackson	1	1	*Inches.* 3	*Feet.* .....
CALIFORNIA.					
BUTTE.					
Cherokee Flat	Spring Valley	14	2	4 to 8	.....
Morris Ravine	Morris Ravine	8	One 1; one 2.	4 to 6	.....
Oroville	Oroville	1	1	.....	.....
CALAVERAS.					
Mokelumne Hill	Bonanza	1	1	.....	100
Do	Duryea	1	1	.....	175
Do	Eureka	2	1	.....	150
Do	Mammoth	1	1	.....	150
Do	Penobscot	3	1	.....	150
DEL NORTE.					
.....	Bunker Hill	1	1	4 and 4½	150
.....	China Creek	2	1	4 and 4½	150
.....	Del Norte	3	1	4 and 4½	100 to 150
.....	Happy Camp	2	1	4½	100 to 275
.....	Muc-a-muc	1	1	4 and 4½	65
.....	Wingate	1	1	3½ and 4	150
PLACER.					
Dutch Flat	Polar Star	2	1	.....	120
Gold Run	Gold Run	4	1	.....	125
Iowa Hill	Orion	1	1	.....	200
Michigan Bluff	Van Emmons	2	1	.....	.....

TABLE LXIX.—HYDRAULIC NOZZLES—Continued.

CALIFORNIA—Continued.

County and district.	Mine.	No. of nozzles.	No. fed by one pipe.	Size.	Mean length of stream.
				Inches.	*Feet.*
PLUMAS.					
Seneca	North Fork	1	1	4	50
	Black Hawk	1	1	1½ and 2½	30
	Hungarian Hill	4	1	6	150
	Plumas M. and W	5	1	6½ and 7	150
SHASTA.					
Igo	Dry Creek	3	1	4½ and 5½	
SISKIYOU.					
Callahan's Ranch	A. B. C	2	1	2 and 2½	60
Galena Hill		1	1	1½ and 2	30
Indian Creek	Bay City	2	1	1½ and 1¾	40 to 60
Do	Coyote Creek	1	1	1½ and 2	30
McAdams Gulch	Hiyou				
Do	Oak Grove	1	1	2 1/16	
Oro Fino	John Young	1	1	2	80
Sciad Valley	Fort Goff Creek	1	1	4½	
Do	Thompson Creek	1	1	4½	30 to 45
STANISLAUS.					
La Grange	La Grange	12	3	4 to 11	150
TRINITY.					
Buckeye	Buckeye	2	1	2	
Cañon Creek	Wilt		1	3	
Douglas	Smith's Flat	1	1		
Indian Creek	Johnston	2	2	6 to 8	
Minersville	Digger Creek				
Red Hill	Evans & Bartlett	1	1	4	
Do	Mammoth			6	210
Do	McKenna		3		
Taylor's Flat	Trinity	1	1		
Weaver	Garden Gulch	2	2		
Do	Harvey Bros	2	2	4	
Do	Holman & Mahon	2	1	4	
Do	Hupp & Murray	2	2	4	
Do	Mabie's Bench	1	1		
Do	Rule Bros	1	1	4	
Do	Weaver Creek	1	1		
	Center Placer	1	1	3	
	Chapman & Fisher	3	3		
	Gribbles	2	1		
	Hager & Haas		1		
	Slattery	2	1	4 and 5	
	Trinity	3	3		
	Wiltshire	2	1		
COLORADO.					
CLEAR CREEK.					
Grass Valley	L. H. Arthur	1	1	2	
Jackson	Edward's	2	2		60
LAKE.					
California	Oro M. D. and F. Co	2	2	3	160
LA PLATA.					
California	Parrot City		1	3	
PARK.					
Alma township	Alma	2	1	4 to 6	100
ROUTT.					
Hahn's Peak	Hahn's Peak M. Co	2	2	3 to 5½	60 to 100
SUMMIT.					
Spaulding	Rob Roy	1	1		105
	Sisler	1	1	1½	60
DAKOTA.					
PENNINGTON.					
Confederate	Stockade	1	1	2	80
Rockerville	Black Hills P. M. Co	1	1	1½	175

TABLE LXIX.—HYDRAULIC NOZZLES—Continued.

County and district.	Mine.	No. of nozzles.	No. fed by one pipe.	Size.	Mean length of stream.
				Inches.	*Feet.*
GEORGIA.					
HALL.					
810 G. M.	Glade	3	1	1½ to 2½	75 to 100
LUMPKIN.					
Twelfth	Battle Branch	1	1		30 to 80
Do	Findley	1	1		10 to 30
Do	Griscom	1	1		
Twelfth and First	Chicago and Georgia	1	1		25
Do	Hand & Barlow	1	1	2	35
Thirteenth	Cleveland & Bugg's Branch	1	1		100
		1	1		15
UNION.					
Tenth and First	Coosa	1	1		80
WHITE.					
Third	Nacoochee	2	1	2	30
Fourth	Forest Springs	1	1	1½	50
IDAHO.					
ALTURAS.					
Elk Creek	Hardscrabble	2	1	2 and 2½	25 to 50
BOISÉ.					
Boston	R. W. Spencer	4	1	1 to 2½	
Moore's Creek	Crepisculla	3	1	2½ to 3	25
Do	Noble, Lower & Mann	1	1		20 to 30
Do	Thorn Creek Company	2	1	2½	50
Pioneer	Hon. Ben. Wilson	13	1	3½ and 4	20 and 40
Do	Stevenson & Noble	2	1	4 and 5	
MONTANA.					
BEAVER HEAD.					
Bannock	Bannock D. and M. Co	1	1		40 to 50
Do	White Bar	1	1		30
DEER LODGE.					
Gold Hill	Squaw Gulch	2	1	3, 4, and 6	130
Henderson Gulch	Butler & Anderson	1	1	2	100
Independence	Oro Fino	1	1	1½	50
Nelson	Pioneer	4	2	2	50
Summit Valley	Noyes & Upton	1	1	2	40
LEWIS AND CLARKE.					
Last Chance	W. A. Cheesman	2	1	2	5
MEAGHER.					
German	Diamond F. and H. Co	1	1	3½ to 6	150
Thompson Gulch	California	1	1	1½	25
Do	Morgan Bar	1	1	1½	15 to 20
Do	Tubbs & Ramsey	1	1		30
NORTH CAROLINA.					
MONTGOMERY.					
Eldorado	Beaver Dam	3	1	1 to 2	150
	San Christian	1	1	2 to 3	14
POLK.					
	Cochrane	1	1	3	10
OREGON.					
BAKER.					
Blue Cañon	Littlefield & Duckworth	1	1	2 to 3	
Do	Marysville	1	1	4	25
Chicken Creek	J. N. Osborne & Co	1	1	2	50
Do	Porter	1	1	3	15
Humboldt Basin	Colt & Co	3	1	3	
					100
Mormon Basin	Rogers & Copeland	1	1	2	
Pocahontas	Baisly	3	1	2, 2½, and 3	20
Do	Baisly & Daly	1	1	2½	150
Do	Low Cooper & Co	1	1	1½	50
Do	Neversweat	3	1	1½, 1½, and 2	30
					30
Do	Salmon Creek	2	1	2 and 4	125
Rye Valley	Powers & Co	5	1	2½	30
Sharps	Ah Moon	1	1	1½ and 2	30
Do	Campbell			3	70
Do	Steiger's French Gulch	1	1	2	70
Do	Stevenson's	1	1	3	80
Sumter	Sumter			2	20
Willow Creek	Boswell	1	1	2½	40

TABLE LXIX.—HYDRAULIC NOZZLES—Continued.

OREGON—Continued.

County and district.	Mine.	No. of nozzles.	No. fed by one pipe.	Size.	Mean length of stream.
DOUGLAS.				*Inches.*	*Feet.*
Big Bend Cow Creek	D. A. Levens	1	1	3	25
Do	J. Fuller	1	1	2	75
Do	Merriam & Anderson	1	1	2 to 2½	75
Do	Salmon	1	1	3, 4, and 6	200
Cañonville	Catchings	1	1	3 and 4	45
Do	McWilliams & Ash	1	1	4 and 4½	180
Green Mountain	Charles Dwelley	1	1	1½ and 2	40
Do	Dyer & Sons	2	1	1½ and 2	30
GRANT.					
Cañon City	Sproul	1	1	3	
Granite	Borne & Lucas		1	2	40
Do	Klopp & Johnson	1	1	4 to 7	60
Marysville	Cannon & Co	1	1	3	150
Do	Hillis			3	50
Do	Thompson	2	1	2½ and 3	50
Rock Creek	Erickson & Owens		1	2½	50
Do	Lasswell & Co		1	2½	30
Trail Creek	Trail Creek	1	1	3½	50
JACKSON.					
Applegate	Grand Applegate	1	1	3	150
Do	Squaw Lake	1	1	6	60
Ashland	Anderson & McCall	1	1	3	30
Coyote Creek	Marshall	1	1	2½	20
Do	Wm. Ruble	1	1	3 to 4	60
Farris Gulch	Farris Gulch	2	1	2	50
Forty-nine	Davenport	1	1	3	30
Do	Forty-nine	1	1	2	40
Sam's Valley	Hays & McGruder	1	1	2	
Sterling	Saltmarsh & Co	1	1	1½	20
Do	Sterling	2	2	6	225
Uniontown	Chapel & Co	1	1	5	150
Do	Gin Lin	2	1	5	150
Wolf Creek	Gross Bros	1	1	3	60
JOSEPHINE.					
Grass Creek	Goff, Triplett & Chapin	1	1	1½	75
Do	Steam Beer	1	1	3	50
Waldo	Desselles & Co	2	1	1½ and 2½	26
Do	Waldo	1	1	3 to 3½	40
Yank	Blue Gravel	2	2	2½ to 6	75 to 100
Do	Josephine	2	1	4½ to 5	75
WASCO.					
Ochoco	Wickaiser & Co	2		1½ and 1½	

SOUTH CAROLINA.

CHESTERFIELD.					
	Brewer	2	1	1½ and 3	35

UTAH.

SALT LAKE.					
West Mountain	Argonaut	1	1	3	80

DUTY OF THE MINER'S INCH.—In loose gravel the excavating power of the hydraulic stream is frequently greater than the transporting power of the same water in the sluices. It would be useless to pipe down more gravel than can be sluiced, so that the transporting power in such cases becomes the measure of duty. Computations made by different engineers, and based upon actual experiment, show a range of between 1 and 10 cubic yards of material moved per 24-hour inch of water (2,250 cubic feet), with an average of about 3 yards per inch. The amount transported depends not only upon the character of the material, heavy and cement gravel requiring much more water than light, loose wash, but also upon the grade of the sluices. An increase in the grade with a given volume of water results in greater carrying capacity, though the exact ratio of increase is not reduced as yet to law. The conditions vary widely in different localities.

WATER-WHEELS.—In some hydraulic mines the power for operating the derricks by which the large bowlders are handled is furnished by water-wheels, usually of the hurdy-gurdy type, in which the direct impact of water under considerable head is directed through nozzles against the periphery of small, rapidly-revolving wheels. The power developed usually ranges between 5 and 20 horse-power for each wheel. These wheels and small overshot wheels are also used in connection with drift mines for pumping and for driving air-compressors and for motive power in the cement mills. Chinese irrigating wheels are sometimes employed to raise water for sluicing in creek washings.

SLUICES FROM BANK TO CHIMNEY.—These are usually cuts in the bed-rock of irregular width, the bottoms of which have a grade of from 6 inches to 1 foot in 12 feet.

SLUICES IN TUNNELS.—The natural rock floor of a tunnel may serve as a sluice, but more commonly the tunnels are fitted with large, substantially-built wooden sluices, having rock riffles of basalt, wooden block riffles, or old railroad iron and scantling faced with iron, as described below.

SLUICES BELOW TUNNELS.—These are constructed after the manner described under the head of flumes, and are really ground flumes designed to carry gravel, etc., in addition to the water, but are more strongly built than the water fluming. A few typical sluices are briefly described in the accompanying table:

TABLE LXX.—DIMENSIONS, ETC., OF SLUICES IN PLACER MINES.

Name.	Location.	IN TUNNELS OR CUTS.				OUTSIDE OF TUNNELS.			
		Width.	Grade.	Length.	Style of riffles.	Width.	Grade.	Length.	Style of riffles.
Black Hawk	Five miles northwest of Quincy, Plumas county.	*Feet.*		*Feet.*		*Feet.* 1½	6 in. in 12 ft	*Feet.* ½ mile.	Blocks.
Del Norte	On Klamath river, near Happy Camp.	2	8 in. in 12 ft	300	Blocks	2½	do	1,200	Do.
Gold Run	One mile southwest of Gold Run, Placer county.	6	6 in. in 12 ft	2,500	Old car rails				
Hager & Haas	In Junction city, Trinity county.								
Harvey Bros	Weaver district, Trinity county.					4	3½ to 7 in. in 12 ft.	1,440	Blocks.
Holman & Mahon	do					3	3 in. in 12 ft	4,800	Do.
John Young	In town of Oro Fino, Siskiyou county.	4 to 5	½ to 1½ in. in 12 ft.	2,000	Blocks	3½	2 in. in 12 ft	3,600	Do.
Oroville	On Feather river, near town of Oroville.					4	2½ in. in 12 ft	2,400	Blocks.
Rule Bros	Weaver district, Trinity county.					3	do	3,000	Do.
Spring Valley	Cherokee Flat, Butte county	6	8 in. in 16 ft	1,800	Basalt	4 to 6	4 to 8 in. in 16 ft.	6½ miles.	Basalt and wooden blocks.
Van Emmons	Town of Michigan Bluffs, Placer county.	2½	12 in. in 12 ft	3,600	Wooden blocks	2½	10 in. in 12 ft	300	Rock.
Weed's Point	Two miles north of Camptonville, Yuba county.	4½	6½ in. in 12 ft	600	Rock and wooden blocks.	3½ to 4	4 in. in 12 ft	4,200	Blocks.
Wiltshire	Trinity county.					4	6 in. in 12 ft	1,200	Do.

GRADE.—The average grade of sluices is 6 inches per box of 12 feet, though if the gravel is very heavy, containing bowlders, a steeper grade is required, and as much as 18 inches in 12 feet is sometimes demanded. Light sandy gravel can be carried on flatter grades than the standard, and in all cases it is advisable to have the sluices set at no steeper grade than is absolutely necessary for the transportation of material.

LINING OF SLUICES.—The sides of the sluices are protected by an interior facing of 2-inch plank, which extends above the riffles as high as the portion exposed to wear.

GRIZZLIES.—These are gratings of parallel iron rails which allow the sand and fine gravel to fall into the undercurrents, while the larger masses are carried on in the main line of sluices or are rolled off to one side out of the way.

DROPS.—Where it is possible, drops of two or more feet are made in the sluice string for the purpose of breaking up pipe-clay and disintegrating cement concretions. Even if the gravel is apparently quite loose and free, such drops can be usefully introduced if there is sufficient fall, and with tough, clayey gravel they are still more valuable.

UNDERCURRENTS.—Wide and very flat sections of sluice, placed by the side of the main line of sluices and fed by the fine material which falls through the gratings, are called undercurrents. Here, the flow of water being comparatively shallow and sluggish, an opportunity is given for the rusty gold and float amalgam to settle. The tailings of the undercurrent are returned again to the main sluice at a point where the grades coincide.

CONSIDERATIONS INVOLVED.—The exigencies are such that in very many mines the engineer is unable to adopt the style of sluices, etc., which would give the best results, and is constrained to resort to the most practicable makeshift. The appliances for saving gold have been developed to a high degree of perfection and are well understood by hydraulic miners, and with the right facilities very efficient means are taken. Given plenty of fall, an abundance of water, and a line of sluices extending along the side of a cañon, the system adopted would be somewhat as follows: A number of drops would be introduced to disintegrate the clayey gravel. By a series of grizzlies the larger sized material (bowlders, pebbles, etc.) would be shot off down the cañon, the apertures between the bars being successively diminished until only the finest gravel and sand would be left in the sluices. It has been recommended that this sizing should be carried to a point where the final siftings should only exceed by two or three diameters the coarsest gold particles found by experience to occur in the mine. This light material could be carried on a quite flat grade with a shallow volume of water, thus making the sluice practically a continuous undercurrent below the point where the last of the refuse, coarse material had been eliminated, or a series of still flatter undercurrents, returning their tailings to the main sluice, could be added. Auxiliary streams of clean water would be used to offset the loss over the grizzlies. The style of pavement and the length of the string would then be a matter of economic judgment.

There is no question but that the rush of water necessary to move heavy barren material through the sluices carries off with it much fine rusty gold and float amalgam. This is corrected in part by the liberal use of undercurrents; but the very efficiency of these undercurrents proves the advantage of light grades and shallow water, which are only compatible with a close sizing of material. If there are twenty-five undercurrents connected with the sluice string (and this number has been reached in some mines), the lowest one invariably is found to save gold and amalgam, though each one successively catches less and less, thus showing that a further development of the system would result in still greater saving. In practice, however, the fall, the amount of water available, and the topography of the country below the mine are seldom such as to allow unlimited choice of means; and, as regards the first cost of the gold-saving plant, the engineer is constantly limited by the consideration of immediate profits. Thus with reasonably permanent plant an undercurrent is seldom added, even if practicable, if it is not thought that it will pay for itself in the course of a couple of seasons. Theoretical perfection must give way to the expediency of the moment in this as in other mining operations.

RIFFLES.—The earliest form of riffle used in sluices was a plain transverse cleat. To resist the heavy rush of water, gravel, and bowlders from large hydraulic workings it is necessary that the pavement and lining of the sluices should be very substantial. The most common form of paving in use consists of blocks of wood, for which heart sugar-pine answers excellently, placed with the grain vertical and securely wedged. These blocks are from 6 to 12 inches thick, more frequently 8 inches, and are either squared, with rounded corners, or more rarely of natural section. The interstices in which the amalgam collects are from a fraction of an inch to 4 inches in width. By reversing the blocks after one side is worn an additional life is secured. In average mines the block riffles last one season, and by turning are made serviceable during two seasons; but if the amount of material carried is comparatively small, the duration is indefinitely extended, as much as five years being reported in exceptional cases.

Rock riffles have been advantageously substituted for wooden blocks in many localities. The rock commonly used is basalt, but quartz and other materials have also been employed. The flooring is set somewhat after the fashion of cobbles, slightly inclined from the vertical, and the pieces are selected with some aim at uniformity. These rock riffles are very durable, and are more economical than wooden blocks, but the labor of handling them in cleaning up is much greater. Usually they are placed in parts of the sluice which it is seldom necessary to clean up. They require more water and heavier grade than do the wooden blocks. At the Spring Valley mine, where the wooden blocks last but three months, the rock pavement remains serviceable just twice as long, though the duration in each case is shorter than is usual, the rock in smaller mines often lasting many years.

Longitudinal slats of scantling, set on edge, arranged somewhat like a grating, make effective riffles, and are very conveniently handled. For this reason they are frequently placed at the heads of sluices, so that these portions may be readily cleaned up. They do not last nearly so long as the block or rock systems; hence, if the wear is excessive, owing to the transportation of bowlders and large pebbles, a facing of iron strips is added. Old rails can be utilized in the same way.

A large number of variations in the style of riffles, some of them patented, have been introduced. It is a very common thing for several systems to be used in the same string of boxes, thus: slats at the head, with alternating sections of block and rock pavement below. The choice of material and of form is governed by economical considerations, by the character and the quantity of the gravel sluiced, and by the fineness of the gold.

WORKING IN BENCHES.—When the bank is very high, and there is danger to the nozzles and the pipemen from caving, it is sometimes the practice to work off the gravel in two or more benches, thus dividing the height. At the Polar Star mine, Placer county, California, the average depth of gravel was 300 feet and the maximum 350 feet. It was found advisable to work this deposit in two benches. Previous to the census year the upper bench, the 150 feet bank, had been piped off and the nozzles were then directed upon the lower bench, which had a bank of 100 feet where being worked. The necessity for working in benches does not, however, very often arise. Very high banks, sometimes as much as 250 feet, are worked in a single bench, though accidents to the apparatus and to the men are apt to occur when very deep deposits are attacked in this way, and if for safety the nozzles are set back from the bank at too great a distance the streams lose force.

DISTRIBUTION OF GOLD AND AMALGAM IN THE SLUICES.—In a string of plain sluice-boxes the bulk of the gold is invariably found at and near the head of the line; and if it is the practice to add the quicksilver in the first boxes, the greater part of the amalgam also is recovered from the same locality. Below, the accumulation of gold and amalgam diminishes in almost geometrical ratio, but if there are undercurrents a noteworthy percentage of the total yield is caught by them, and the proportionate amounts saved by each of a series of undercurrents is in inverse ratio to their order of succession. At the mines where ground-sluicing forms the main reliance the gold is similarly deposited near the heads of the cuts. The testimony on this point is unanimous and agrees quite closely in detail. The statements received from the following mines will illustrate the manner in which experience has shown the distribution of gold to occur. Other returns, given with less particularity, show a similar mode of occurrence.

ARIZONA.

Jackson: Mostly in first 2 boxes.

CALIFORNIA.

A. B. C.: Mostly within 50 feet of head.
Bay City: 90 per cent. in first 10 boxes.
Black Hawk: In first 20 boxes.
Bunker Hill: 80 per cent. in first 10 boxes.
Carroll: Nearly all in upper boxes.
China Creek: 66 per cent. in first 10 boxes.
Coyote Gulch: 90 per cent. in first 15 boxes.
Del Norte: 90 per cent. in first 15 boxes.
Dry Creek: 90 per cent in first 10 or 15 boxes.
Duncan Cameron: Nearly all in upper boxes.
Duryea: Mostly in first 150 feet.
Evans & Bartlett: 75 per cent. in first 4 boxes.
Happy Camp: 90 per cent. in first 10 boxes.
Hardscrabble: Nearly all in upper boxes.
Harvey Bros.: 90 per cent. in head boxes.
Hidden Treasure: Mostly within 200 feet from head.
Hiyou: 80 per cent. in upper boxes.
Hungarian Hill: Mostly in first 20 boxes.
Hupp & Murray: 80 per cent. in first 700 feet.
John Young: 80 per cent. in first 15 boxes.
Johnston: 75 per cent. in first 10 boxes.
La Grange: 90 per cent. in upper boxes.
Lewiston: 90 per cent. within 50 feet of head.
Lincoln, Hart & Henry: Nearly all in upper boxes.
Magalia: Mostly in first boxes.
Mammoth: Mostly in first 175 feet.
Mammoth: 95 per cent. in first 100 feet, 25 per cent. in undercurrents.
McKenna: 50 per cent. in first 50 feet, 10 per cent. in undercurrents.
Morris Ravine: Mostly in first 20 boxes.
Muc-a-muc: 75 per cent. in first 10 boxes.
North Fork: In first 3 boxes.
Oroville: Mostly in first 10 boxes.
Pellet & Truitt: 90 per cent. in bed-rock sluices.
Penobscot: 90 per cent. near head of sluice.
Plumas M. and W.: Mostly in first 20 boxes.
Rule Bros.: 80 per cent. in first 180 feet.
Siwash: Nearly all in upper boxes.
Trinity: 90 per cent. in first 120 feet.
Wingate: 80 per cent. in first 10 boxes.

COLORADO.

Blue River: Mostly in first 200 feet.
Hahn's Peak: Mostly in first 3 boxes.
Rob Roy: Mostly in first 100 feet.
Sisler: Mostly in first 75 feet.

GEORGIA.

Battle Branch: Five-eighths in first 20 feet.
Cleveland & Buggs' Branch: Mostly in first 50 feet.
Coosa: 95 per cent. in first 10 feet.
Forest Spring: Over 50 per cent. in first 36 feet.
Glade: 90 per cent. on bed-rock.
Griscom: In upper 50 feet of boxes.

IDAHO.

Crepisculla: Mostly in first 6 boxes.
Hon. Ben. Wilson: Mostly in first 6 boxes.
Noble, Lower & Mann: Mostly in first 2 boxes.
R. W. Spencer: Mostly in first 6 boxes.
Thorn Creek: Mostly in first two boxes.

MONTANA.

Butler & Anderson: Mostly in first 3 or 4 boxes.
California: Seven-eighths in first 4 boxes.
Charles Pryse: Mostly in first boxes.
Diamond F. and H. Co.: Mostly in first quarter of sluice.
Morgan Bar: 75 per cent. in first 3 boxes.
Pioneer: Mostly in first 3 boxes.
Shoup & Blume: Mostly in first 3 boxes.
Squaw Gulch: Mostly in first 10 boxes.
Tubbs & Ramsey: 75 per cent. in first 3 or 4 boxes.
White Bar: Mostly in first 3 boxes.

NORTH CAROLINA.

Cochrane: Mostly in first 2 or 3 boxes.

OREGON.

Ah Moon: Mostly in first 2 boxes.
Anderson & McCall: 90 per cent. in first 2 boxes.
Baisly: 90 per cent. in race.
Baisly & Daily: 90 per cent. in race, balance in first 5 boxes.
Borne & Lucas: Mostly in first 2 boxes.
Cannon & Co.: 90 per cent. in race.
Catchings: Mostly in 2 upper lengths.
Colt & Co.: Nine-tenths in the race.
Dyer & Son: In first 2 boxes.
Gin Lin: Mostly in first 4 boxes.
J. N. Osborne & Co.: Two-thirds in race and first 3 boxes.
Klopp & Johnson: Mostly in first 2 boxes.
Grand Applegate: 90 per cent. in first 2 boxes.
Lew Cooper & Co.: Seven-eighths in the race, balance in first 3 boxes.
Littlefield & Duckworth: Seven-eighths in the race, balance in first 5 boxes.
Marshall's: Five-eighths in first 2 boxes.
Marysville: Nine-tenths in the race.
Neversweat: 95 per cent. in the race, balance in first 5 boxes.
Porter: Three-fourths in race and first 3 boxes.
Powers & Co.: 90 per cent. in the race.
Rogers & Copeland: Three-fourths in the race, balance in first 3 boxes.
Salmon: Mostly in first 2 boxes.
Salmon Creek: 90 per cent. in the race, balance in first 100 feet.
Sproul: 90 per cent. in the race, balance in first 3 boxes.
Squaw Lake: 90 per cent. in first two boxes.
Steiger's French Gulch: Mostly in first and second boxes.
Sterling: Mostly in first 10 boxes.
Stevenson's: Mostly in first box.
Trail Creek: Mostly in first 3 boxes.
W. Boswell: Mostly in upper boxes.
W. Ruble: Three-fourths in ground sluices.
Wickaiser & Co.: In first 3 boxes.

This concentration of the gold within a comparatively narrow distance allows a frequent partial clean-up of the more productive boxes to be made, while the greater portion of the line can be left untouched for a longer run. For this reason a double set of upper boxes, arranged as are the arms of a Y and converging toward the main line, may be recommended where it would not be economically expedient to adopt a complete double-string of sluices, so that the washing of gravel need not be interrupted while one set of head-boxes is being cleaned up. But the fact that most of the gold is found near the upper part of the sluices is no reason why the string of boxes should be shorter than the limit fixed by the demands of expediency, for sluice plant is never so perfect that some saving of gold may not be made at its extremity.

Loss of gold and quicksilver.—The admirable economy of the hydraulic process, which admits of handling material containing an average of a few cents only per cubic yard, leads also to some uncertainty as to the proportion of gold which is saved, and this very important question becomes rather a matter of opinion than of absolute knowledge. Means of testing the tailings are simply a continuance or extension of methods adopted in the gold-saving appliances, for the minute and irregular dissemination of the fine gold particles is such as to defy the fire-assay or any similar means. If, therefore, a careful reworking of the tailings is undertaken and the results obtained are insignificant, it merely proves that no large amount of gold which is susceptible to the amalgamating and gravity appliances in use has escaped in the first treatment—not that there does not exist a considerable quantity which, from excessive fineness or peculiar chemical attributes, would be lost were the ordinary means of gold-saving indefinitely extended.

In the majority of well-appointed hydraulic mines it is claimed, and apparently with good reason (though not with any degree of precision), that about 90 per cent. of the gold present in the gravel is saved, and some intelligent miners consider that the loss is even less. On the other hand, in a few cases, generally where the sluices are not sufficiently extended or because of very clayey material, a loss of 33 per cent. is admitted. These are wide ranges of expression, it is true, but still it cannot well be doubted that the working of an average hydraulic mine gives closer results than does the ordinary mill process.

With well-designed plant even gold may be lost because of at least three known conditions: It may be so microscopically comminuted, and in such thin flakes, as not to sink in the thick muddy water of the sluices; or, after being taken up by the quicksilver, the resulting amalgam may be floured and similarly carried off in the water; or, finally, it may be protected by its quartz matrix and escape in its native pebble. For the last difficulty there is no remedy, since crushing gravel of the usual tenor worked in hydraulic mines is evidently out of the question.

In the mines where careful retorting is practiced and the bulk of the quicksilver lost escapes from the sluices the consumption of this metal is very considerable. The range of loss is reported to extend to from 5 to 37½ per cent. of the quantity used, and in the majority of cases from 10 to 15 per cent. is known to escape. The loss of quicksilver involves the loss of gold, but in what ratio is not known. The amalgam from undercurrents has been found to be poorer in gold than that from the main sluices. As the consumption of quicksilver is a known element, a careful and somewhat extended investigation into the tenor of amalgam collected from different portions of the sluices and escaping in the tailings might lead to useful results, and at least would indicate approximately the ratio in which gold that is susceptible to amalgamation is lost as compared with the waste of quicksilver. It is worth while to recall, in this connection, the well-known fact that float amalgam has been caught at distances of 20 miles from the point where the sluices from which it had escaped tailed into the stream.

Retorting of amalgam.—After removing the excess of quicksilver by straining and washing the amalgam is retorted, commonly in cast-iron bulb-retorts, and the distilled quicksilver is collected under water. At a few of the larger mines the retorted amalgam is melted into bars, weighed, and stamped, but usually it is sold in the crude state. At many of the smaller mines, and particularly in new districts where there are no facilities for retorting, the amalgam, after straining as closely as possible by hand through chamois or cloth, is placed in a pan or on a shovel and the remainder of the quicksilver is volatilized in the open air over a common fire.

Length of shift.—Most of the large hydraulic mines during the height of the season are worked full time, or with two shifts of ten hours each, thus running twenty hours per day. When, because of scarcity of water or for other reasons, the mines are worked during the day only, the shift is from ten to twelve hours. Although the work in hydraulic mines is often laborious, it is of a healthful nature, and is probably not a greater tax upon the men than is the shorter shift common in underground mining.

Length of season.—This depends on the duration of the period during which water can be supplied, and is limited by either ice or drought. For the more important hydraulic mines the average length of season throughout the country may be stated at about 200 days, though during the latter part of the run most of the mines are worked on half time or less and with diminishing water supply. Of the unreported mines the season is known to be much shorter than the period mentioned.

Economy in hydraulic mining.—This method of mining depends for its success on handling vast quantities of matter of so low a grade as to yield but a few cents per cubic yard. In many mines the product is not above 10 cents per yard, and in some favorably-situated workings a considerably lower rate of production results in profit.

Professor Whitney's (*a*) estimate was that gravel yielding 4½ cents per cubic yard could be profitably worked under the best conditions. Since this opinion was published a still lower tenor has been shown to be profitable. Between 1870 and 1874 the North Bloomfield Company (*b*) washed three and a quarter million cubic yards of top gravel, yielding 2.9 cents per cubic yard, at a bare profit of only $2,232 84, showing, however, that a very slight improvement in the quality of the gravel would have rendered a considerable profit. The conditions necessary for cheap working are not only an abundant water supply, sufficient dump, and high banks of loose fine gravel which can be easily piped, but in addition to these there is required the closest attention to details and the strictest economy on the part of the management.

COST OF HYDRAULIC MINING.—The method of measuring the cost, yield, and profit of hydraulic mining is a question concerning which opinions differ. The estimate of product based on the quantity of material moved is the most common, but the conditions vary so greatly in different places that for purposes of comparison this mode has but little value, while the measurement of the irregular bodies worked is also a matter of some uncertainty. Indeed, objections may be raised against each of the other ways proposed, such as stating the yield per miner's inch of water used, per square foot of bed-rock stripped, or the cost per ounce of gold extracted. Custom has so established the method of calculating product and cost by the cubic yard of gravel washed that this is likely to remain the standard, though for technical purposes the product per miner's inch of water used forms a simple means of comparison, and is preferred by many engineers as being more generally applicable. From a purely business point of view the expenses and the profits are perhaps best shown by reference to the product at its market value. Thus, for example, to produce a dollar in gold the costs would be stated as so many cents for labor, for water, for powder, for quicksilver, etc., each item forming a percentage on the product without further computation. This latter mode also permits of comparison with the results obtained in other branches of mining and in industrial pursuits in general.

A cubic yard of gravel may be taken at from 1½ to 1¾ tons. When it is considered that this quantity of material can be handled under the best circumstances at a cost of less than 3 cents by the hydraulic process, some idea of the wonderful economy and efficiency of this means of mining may be gained. If a ton of gravel is treated at a cost of 2 cents, the expense is between one-fiftieth and one one-hundredth of the minimum outlay involved in mining and milling the most favorably situated and most easily reduced free-milling gold ores. The average cost of hydraulic mining bears about the same relationship to the average cost of mining and reduction of auriferous vein deposits as does the minimum. A comparison with the expense of mining and reducing rebellious silver ores shows a still wider divergence. Thus, if the two extremes are stated at 2 cents per ton for working gravel under the very best possible conditions and $100 per ton for mining, hauling, and reducing the silver ore under exceptional disadvantages, the range in cost of handling similar weights of material is expressed by the ratio 1 : 5,000. In addition to the obvious advantages possessed by the hydraulic process, such as saving in labor, etc., and the capability of handling vast quantities of material with great rapidity, a feature which especially characterizes it is the fact that it is continuous and very nearly automatic throughout, while in vein mining the process is divided into at least two distinct operations, mining and reduction, with possibly many successive handlings in which manual labor is more or less involved.

The minimum cost of hydraulic mining, taken from the accounts of a few of the largest, most favorably situated, and most economically and skillfully worked mines, is apt to be misleading if applied as a basis for calculation in projecting new enterprises. While a very few exceptional mines are worked at a cost of between 2 and 3 cents per cubic yard, it is probable that the average cost for all the hydraulic mines of the country, large and small, is not less than 10 cents per yard, while among the census returns are cases ranging all the way from this point up to between 40 and 50 cents per yard.

The itemized costs of mining during the census year at a few specimen hydraulic mines in the northern part of California are cited in Table LXXI, and in Table LXXII the results of operations at a group of mines in Stanislaus county, and at the North Bloomfield mine of Nevada county, are shown. The figures of the latter table are for an irregular period, about four years previous to the present investigation, and are from data compiled by Mr. Augustus J. Bowie, jr.

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a *Auriferous Gravels*, p. 371.

b Hydraulic Mining in California, *Transactions Am. Inst. of Mining Engineers*, vol. vi, p. 35.

TABLE LXXI.—COST OF HYDRAULIC MINING AT VARIOUS MINES IN DEL NORTE AND SISKIYOU COUNTIES, CALIFORNIA.

Cost of—	Bunker Hill.	China Creek.	Happy Camp.	Muc-a-muc.	Wingate.	Bay City.	Coyote Gulch.	Thompson's Creek.
Labor	$4,950 00	$2,187 36	$8,586 00	$1,039 00	$4,288 50	$835 00	$1,950 00	$1,095 00
Repairs to ditch	.....	.....	1,000 00	56 00	.....	.....	.....	.....
Powder and fuse	2,250 00	315 00	500 00	135 00	800 00	.....	.....	.....
Blocks, etc	1,000 00	412 80	1,587 00	110 00	500 00	100 00	24 00	40 00
Boxes	60 00	120 00	.....	.....	60 00	100 00	30 00	.....
Quicksilver	150 00	45 00	25 00	12 00	35 00	.....	14 00	28 00
Tools	50 00	100 00	100 00	.....	50 00	.....	50 00	.....
Sundries	200 00	20 00	.....	148 00	200 00	.....	.....	100 00
Total	8,660 00	3,180 16	11,800 00	1,500 00	5,933 50	1,035 00	2,068 00	1,263 00
Number of cubic yards of gravel moved	132,300	32,234	314,000	22,554	263,000	24,750	31,740	19,000
Cost of moving 1 cubic yard	$0.0654	$0.0987	$0.0375	$0.0665	$0.0225	$0.042	$0.065	$0.0645

TABLE LXXII.—COST OF HYDRAULIC MINING AT VARIOUS MINES IN STANISLAUS AND NEVADA COUNTIES, CALIFORNIA.

Cost of—	Chesnau.	French Hill.	Johnson.	Light.	North Bloomfield.	Sicard.
Labor	$0.036	$0.042	$0.02	$0.022	$0.0225	$0.025
Blocks and lumber	0.0042	0.0042	0.0020	0.008		0.0061
Material	0.0062	0.0057	0.0076	0.0015		0.0038
Melting and refining	0.0005	0.0004	0.0004	0.0003		0.0007
Water	0.008	0.0104	0.006	0.006	0.0075	0.004
Total cost per cubic yard	0.055	0.062	0.037	0.038	0.03	0.039
Yield per cubic yard	0.16	0.13	0.04	0.066	0.0333	0.13
Yield per inch of water	0.23	0.14	0.08	0.12	0.23	0.37
Number of cubic yards of gravel washed	284,932	676,908	196,632	683,344	4,104,700	155,347
Total yield	$47,781 73	$90,186 19	$9,148 27	$45,444 65	$267,607 50	$20,197 07
Total cost	15,923 71	42,655 83	7,465 99	25,962 82	147,912 58	6,205 40

PROFITS IN HYDRAULIC MINING.—When a mine is fully developed, the returns are very regular and uniform and can be counted on with quite as much certainty as, for instance, in manufacturing pursuits. Indeed, it is usually possible to estimate beforehand with considerable precision whether the returns from a given undertaking are likely to pay for the expense of opening the mine. The chief elements of uncertainty are the amount of rainfall and the duration of the working season, which in all localities are liable to vary from year to year. These remarks, of course, apply mainly to claims having deep beds of gravel and worked upon a somewhat large scale, and in such mines, while there is not the constant excitement dependent upon the possibilities of sudden strikes and bonanzas, there is, on the other hand, little fear of the mine "petering" so long as there is a good gravel bank in sight and the means of working it are at hand. Hence it is that few hydraulic mines are worked at a loss, except during the prosecution of dead-work necessary to development, or, perhaps, in unexpectedly short seasons. The hydraulic miner can easily ascertain whether it is worth while to continue operations, and when he finds himself running behind he is apt to close down at once. The amount of work done and of money invested in this class of enterprises is therefore very closely adjusted to the possibilities of profit. While, however, there are a large number of mines operated on a bare margin of profit, it is believed that, leaving out of consideration the value of the permanent investment, the running expenses average hardly more than 50 per cent. of the gross yield.

PRESENT STATUS OF THE INDUSTRY.—From the inception of hydraulic mining the tendency has been constantly toward improvement in method and increase in the scale of operations, necessitating the employment of large capital, and, consequently, a consolidation of interests. At present the more important enterprises are prosecuted by strong corporations, which are able to perform an immense amount of preliminary dead work before receiving any returns; but, on the other hand, many small mines are still yielding handsome profits on smaller investments to individual owners. Progress has been made chiefly in an extension in the field of operations, larger tracts being developed and heavier rigs brought to bear. Greater amounts of water, at higher heads, and nozzles of larger aperture; long tunnels, extended strings of sluices, and the use of double lines of sluices; increase in the number of undercurrents, drops, grizzlies, etc.—these are the principal directions in which advance is continually manifesting itself. Each year brings new knowledge, and though the hydraulic method has again and again been declared to be as near perfection in point of practical economy as could be hoped for, still there is reason to believe that, while the general principles are now well established, the future has in store many further improvements.

In California a serious set-back has occurred in the conflict between the hydraulic mining interest and the farmers whose lands, on the line of drainage below the mines, have been injured by the deposit of tailings from the mines. Damage has also been done the navigable rivers by the same cause. During the census year some of the important mines were closed down for a considerable time by injunctions restraining them from working, and much litigation was in prospect. The miners have, however, pending the final solution of the difficulty, of their own accord taken steps to impound their tailings by dams; and whether the system proposed by Lieutenant-Colonel Mendell is carried out by state aid or by that of the general government, or not at all, the agitation of the *débris* question will undoubtedly result in checking the damage, though if the miners are compelled, unaided, to restrain their tailings the necessary improvements will add to the cost of mining. One effect of the "slickens" controversy will undoubtedly be a resort to drift mining for certain placer deposits.

DRIFT MINING.

This method of working placer deposits is practiced in localities where the gravel is overlaid by lava, or where the paying portion is concentrated in a thin stratum on the bed-rock under a deep wash of barren or very low grade gravel which could not be profitably mined by the hydraulic process. It also takes the place of hydraulic mining in places where, from scarcity of water or insufficiency of dump room, it would be impracticable to move the whole depth of the deposit by piping.

The system of mining is analogous to that followed in vein mines. The deposit is opened by tunnel, shaft, or incline to the bed-rock, developed by cross-cutting, and the pay-streak stoped out. The latter usually consists of about 3 feet of gravel lying immediately upon the bed-rock, with the upper portion of the bed-rock itself to a depth of from a few inches to sometimes 3 feet. The gravel is shoveled into hand-cars and wheeled out to the mouth of the tunnel, or is loaded in buckets upon "buggies" and carried to the bottom of the shaft, where it is hoisted to the surface. The gold is extracted by simply washing in sluices, though sometimes the gravel is first crushed in a cement stamp-mill. As the gold on the bed-rock is sometimes very coarse, sluicing without quicksilver is in such cases practicable. In the underground workings careful timbering is required; and in breasting out the gravel pillars are left protecting the main galleries, or square sets of timber are introduced, which are filled with waste. Blasting is practiced to some extent, but in many of the mines the gravel is soft picking ground. Pumping is often required, the pumps being driven by water or steam power.

Drift mining is conducted extensively in Sierra and Placer counties; also in Siskiyou and El Dorado counties, California. The agitation of the *débris* question has redirected attention to this branch of mining, and its importance is increasing. At present it is thought that about one-third of the deep-placer product of the state is from drift mines. It is also practiced to a limited extent in various portions of the territories. Some of the California mines have yielded largely, as may be seen from the following specimen cases:

TABLE LXXIII.—PRODUCT OF SPECIMEN DRIFT MINES IN CALIFORNIA.

Mine.	Locality.	Length of claim.	Yield per linear foot.	Product.
		Feet.		
Hidden Treasure	Placer county	10,560	$294 00	*a* $274,283 00
Bald Mountain	Sierra county	7,500	464 00	*b* 1,728,616 00
Hawkeye	do	800	437 50	*c* 350,000 00
Empire	do	1,560	482 05	*c* 752,000 00
Monumental	do	1,040	312 00	*c* 325,000 00
Pittsburgh	do	800	506 00	*c* 430,000 00
Union	do	2,400	625 00	*c* 1,500,000 00

a To May 1, 1880. *b* 1872 to August 1, 1880. *c* 1870 to 1880.

COST OF DRIFT MINING.—The conditions which determine the expense of mining on this plan vary widely. Favorably situated deposits, requiring neither hoisting nor pumping appliances, can be worked at extremely low costs; on the other hand, if the water is troublesome, the ground loose, and the pay irregularly disposed, the expenses are much enhanced. Thus, while gravel yielding a trifle over $1 per yard can be made to pay a profit under favorable conditions, in other localities an average tenor of $3, $4, $5, or $6 per yard will barely cover expenses. At the Lyon mine, El Dorado county, California, where the cement is crushed by stamps, gravel yielding an average of $3 per ton is profitable; and at the Paragon mine, in Placer county, where crushing is also practiced, gravel of the same grade yields a handsome profit above the cost of mining and milling. An average of $2 per ton covers expenses at the Hidden Treasure mine, Michigan bluffs. An analysis of the cost of mining in a series of mines in McAdams and Indian Creek districts is appended. These mines are shallow workings, from 28 to 74 feet in depth, the shafts penetrating a light wash and tailings. The "pay" is quite regular, lying on and in the bed-rock, and is stoped out on the long-wall system, hoisted in buckets to the surface by horse-whims, and washed in sluices near the shaft mouths.

TABLE LXXIV.—COST OF DRIFT MINING IN McADAMS AND INDIAN CREEK DISTRICTS, SISKIYOU COUNTY, CALIFORNIA.

Cost per cubic yard mined.	Cameron mine.	Carrol mine.	Hardscrabble mine.	Lincoln, Hart & Henry, and Oak Grove mines.	Siwash mine.	Williams mine.
Total cost of drift mining per cubic yard	$1.207	$1.629	$1.50	$1.634	$0.915	$0.89
Labor	0.952	1.148	1.00	1.148	0.66	0.552
Timber	0.15	0.316	0.31	0.316	0.15	0.164
Powder				0.005		
Lights	0.02	0.064	0.05	0.064	0.02	0.012
Falls						0.096
Horse-feed	0.02	0.027	0.03	0.027	0.02	0.016
Incidentals and wear and tear	0.065	0.074	0.12	0.074	0.065	0.11

GRAVEL MILLS.—Cement gravel, if rich enough, and sometimes also gravel which is quite loose, is crushed in stamp-mills of the same character as those working on free-gold ores from veins but fitted with very coarse screens.

The gravel from the Lyon mine, El Dorado county, California, is crushed by a 20-stamp mill driven by water power. The stamps weigh 450 pounds each, and drop 90 times per minute, with an 8-inch fall. Thirty miner's inches of water under a head of 130 feet furnish the motive power. Of the total amount of gold saved 80 per cent. is caught in the battery. Outside of the mortar the pulp flows over a silver-plated copper apron, and thence through 800 feet of sluices. But little gold is recovered from the sluices, however. The material is crushed without previous sizing.

The mill of the Paragon Company, in Placer county, California, has 10 stamps of 850 pounds each, with steel shoes and dies, dropping 90 times per minute, with a fall of 10 inches. The mill is driven by steam. The capacity is 40 tons per 24 hours. Here the coarser gravel and bowlders are not crushed, but only the finer and softer gravel. The screens are sheet-iron, with $\frac{3}{16}$-inch round holes. From 60 to 70 per cent. of all the gold saved is caught by battery amalgamation, from 20 to 25 per cent. on aprons, and the remainder by a concentrator and in 150 feet of sluices. The record of a continuous run from September 19, 1879, to April 14, 1880, as quoted by Mr. W. A. Skidmore, gave the following results:

Car-loads of gravel crushed	4,241
Total yield	$44,835 53
Average yield per car-load	$10 57
Average yield per ton	$7 05
Average cost per car-load, mining and milling	$3 94

ACCIDENTS IN PLACER MINING.

While a very large number of minor accidents, usually caused by the caving in of banks, occur in placer mining, these for the most part are confined to mere bruises, and do not permanently disable the miners. In comparison with the number of men employed in this branch of mining serious accidents are infrequent. The returns for the census year include only thirty-seven casualties considered worth reporting; of these, thirteen resulted in death, and twenty-four were not fatal. The number of men killed and injured by caving was nearly four-fifths of the total accidents reported, while the next most frequent cause appears to have been the premature explosion of powder in bank-blasting or in blowing up bowlders, stumps, etc. The returns are necessarily imperfect, owing to the fact that a large number of the smaller claims were not reported upon in detail. The following table illustrates, however, with sufficient clearness the relative frequency of the different classes of accidents, and the average frequency with which the latter occur in mines of the largest extent and employing the greatest number of hands:

TABLE LXXV.—ACCIDENTS IN PLACER MINING DURING THE CENSUS YEAR.

State or territory.	CAUSE AND NUMBER.									
		Fatal accidents.			Accidents not fatal.					
	Total accidents.	Total fatal accidents.	Caving of bank.	Premature explosions.	Total accidents not fatal.	Caving of bank.	Premature explosions.	Crushed by log.	Carelessness in handling tools.	Unclassified.
The United States	37	13	11	2	24	17	2	1	2	2
Arizona	1				1	1				
California	28	9	8	1	19	12	2	1	2	2
Colorado	1	1	1							
Dakota	1	1	1							
Idaho	1				1	1				
Oregon	5	2	1	1	3	3				

MINING DITCHES.

The system of artificial water channels, made necessary by the requirements of hydraulic mining, and serving also to supply placer mines not worked by the hydraulic process, as well as quartz-mills and other works, has become of vast extent and importance. There are now over 10,000 miles of ditch lines in the United States, which, with their flumes, pipes, reservoirs, etc., represent an investment of $27,000,000, exclusive of the purchase of water rights. In the construction of these lines many novel problems have arisen demanding the exercise of a high degree of engineering skill. Some idea of the magnitude of the water interest may be gained from the following exhibit:

Total length of ditch lines	(miles)	10,783
Total length of ditches proper	do	10,183
Total length of flumes	do	450
Total length of pipes	do	150
Greatest length of lines under one ownership	do	290
Average length of ditch lines reported, including feeders, etc	do	26
Average length of all California lines	do	12¼
Maximum capacity of ditch lines	(gallons per 24 hours)	7,560,000,000
Total cost of plant, including reservoirs, etc., and excluding cost of water rights	(dollars)	27,056,942 11
Average cost per mile, including reservoirs, etc., of lines reported	do	3,800 60
Average cost per mile, including reservoirs, etc., of all lines	do	2,509 22
Highest cost of plant reported under one ownership	do	2,100,000 00
Nominal capital stock of 13 corporations, exclusive of mining companies owning ditches	do	38,805,000 00
Working capital of 27 lines	do	1,451,300 00
Total annual expense of maintenance	do	827,280 41
Annual cost of repairs	do	200,288 66
Annual cost of attendance, exclusive of repairs	do	626,991 75
Average length of season of lines reported	(days)	211¼

An analysis of the returns shows that of 152 lines for which the ownership is specified 88.82 per cent. are owned in the state or territory where they are situated, while 11.18 per cent. are owned in other states or territories. Of the latter more than one-half are controlled by New York capitalists. The ditches are largely owned in connection with the mines which they supply, though a few very important lines are operated by water companies not engaged in mining. Thus, of 171 hydraulic mines from which particulars as to ownership of water were received, 136 own the water which they use and 35 buy it from the owners of ditches. Table LXXVI shows the manner in which the ownership of the ditch lines is divided:

TABLE LXXVI.—LOCALITY OF OWNERSHIP OF MINING DITCHES.

State or territory in which ditch lines are located.	Total number of lines with ownership specified.	Owned in state or territory where located.	Owned in other states or territories than those in which the lines are located.								
			Total.	California.	District of Columbia.	Illinois.	Indiana.	Massachusetts.	New Mexico.	New York.	Pennsylvania.
Total	152	135	17	1	1	1	2	1	1	9	1
Alabama	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arizona	2	1	2	.....	.....	.....	.....	.....	1	1	.....
California	43	37	6	.....	.....	.....	2	.....	.....	3	1
Colorado	8	6	2	.....	.....	1	.....	1	.....	.....	.....
Dakota	6	4	2	.....	.....	.....	.....	.....	.....	2	.....
Georgia	8	4	4	.....	1	.....	.....	.....	.....	3	.....
Idaho	16	16	.....	.....	.....	.....	.....	.....	.....	.....	.....
Montana	11	11	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oregon	56	55	1	1	.....	.....	.....	.....	.....	.....	.....

CAPITAL STOCK OF WATER COMPANIES.—Thirteen corporations, exclusive of mining companies owning ditches, report an aggregate nominal capital of $38,805,000. Nominal capital, it should be observed, bears very little relation either to the cost or to the value of plant.

WORKING CAPITAL.—The replies to an inquiry as to the actual working capital of water owners (exclusive of that considered elsewhere under the head of hydraulic mines) were very scanty and useless for statistical purposes. In California two ditch lines reported $504,000 working capital, in Georgia one line reported $200,000, and in Oregon 24 lines reported $747,300. The aggregate of these returns from 27 lines is only $1,451,300—a sum insignificant in comparison with the true total. At the same time it should be noted that in a large number of cases "working capital" is represented by the gross receipts from the sale of water, or by profit in mining where the water is used by the owners.

EXTENT OF PLANT.—The following list gives particulars as to the total length of a large number of important water-lines, the length of fluming and pipes (exclusive of feed-pipes on hydraulic mines), and the reservoirs, as reported by the census experts. It includes a few lines which supply water for quartz-mills and not for hydraulic mining, and several which carry water both for mining and for other uses. These details are summarized by states and territories in Table LXXVIII. The totals reached are merely the aggregates of the direct schedule returns. While the latter cover most of the important ditch lines, a few large ones and many of the smaller ones not reported upon in detail are omitted. An estimate of the actual total extent of ditch plant is elsewhere appended.

TABLE LXXVII.—EXTENT OF PLANT OF MINING DITCHES REPORTED UPON IN DETAIL.

County and district.	Ditch.	Total length of line, including flumes, etc.	Reservoirs.		Length of flumes.	Length of pipes.
			Number.	Capacity.		
ALABAMA.						
CLAY.		*Miles.*			*Feet.*	*Feet.*
Idaho		1			600	
ARIZONA.						
APACHE.						
Greenlee Gold Mountain	Boston	1½			325	
MARICOPA.						
	Vulture Pipe Line	16				84,480
YAVAPAI.						
	Jackson	1½	1		312	1,200
CALIFORNIA.						
BUTTE.						
Cherokee	Spring Valley	100	2	300,000,000 cubic feet	12,000	23,640
Morris Ravine	Morris Ravine	40	1	8,000,000 gallons	21,120	10,560
Oroville	Feather River and Ophir	25	4	500 inches each for 24 hours	13,200	None.
CALAVERAS.						
Mokelumne Hill	Cook & Clarke	41			7,920	21,120
	Mokelumne and Campo Seco	100	6		10,560	
	Union	40	1			None.
DEL NORTE.						
	Bunker Hill	5½	1	300 inches per diem for 2½ months	13,200	
	China Creek	3½	1	1,667,500 gallons	1,620	None.
	Del Norte	10			2,640	
	Happy Camp	23½	1	400,000 gallons	21,120	
	Muc-a-muc	4½			5,280	None.
	Wingate	10			7,920	None.
EL DORADO.						
Georgetown	California	250	13	600,000,000 cubic feet	13,200	
	El Dorado	110	2	1,070,000,000 cubic feet	5,280	15,840
	Park Canal	200	1		63,360	4,000
NEVADA.						
Nevada City	South Yuba	123	4	Total, 473,000 inches	18,480	
PLACER.						
Gold Run	Gold Run	80	5	Total, 20,000 inches	23,760	12,000
Iowa Hill	Iowa Hill	25	2		5,280	None.
PLUMAS.						
Indian Valley	Round Valley	8	1		2,500	None.
Seneca	Dutch Hills	33½	2	Tule lake, and one reservoir of 3,627,000 gallons.	26,960	42,240
	Black Hawk	4½	2	112,000 gallons each	None.	None.
	Hungarian Hill	10	1		None.	
	Plumas	40	2	Lakes	588	None.
SHASTA.						
Igo	Dry Creek	28½			10,560	
SISKIYOU.						
Indian Creek	Bay City	10			1,200	None.
Do	Coyote Creek	5½	1	900,000 gallons	410	None.
McAdams Creek	Hiyou Gulch	2	1	67,500 gallons	600	None.
Oro Fino	Altoona	18			400	None.
Do	Barker	6			1,000	None.
Do	Wright & Fletcher	7½			1,000	None.
Do	Young's	10			None.	None.
Quartz Valley	Beaver Dam	1½			None.	None.
Do	Shackelford Creek	14			480	None.
Sciad Valley	Fort Goff	28				
Do	Thompson Creek	1			None.	
Yreka	Pellett & Truitt	1	2	Total, 550,000 gallons	None.	

TABLE LXXVII.—EXTENT OF PLANT OF MINING DITCHES REPORTED UPON IN DETAIL—Continued.

CALIFORNIA—Continued.

County and district.	Ditch.	Total length of line, including flumes, etc.	Reservoirs.		Length of flumes.	Length of pipes.
			Number.	Capacity.		
TRINITY.		Miles.			Feet.	Feet.
Buckeye	Buckeye	39½	4		5,280	3,000
Hayfork	(Four ditches)	12				1,700
Do	Fry Brothers		1	500 inches		
Do	Hubbard & Edwards	4	1			
Do	Hurst & Eliason	1				
Do	New River	9			26,900	
Do	Point Bar	4				
Do	Tourot	4				
Indian Creek	Johnston	5				
Junction City	Lewiston	7			200	
						1,500
Lewiston	Chamberlain	5				
Do	Chinese Company	7½				
Do	Cunningham	3½				
Mineraville	Ridgeville	11½	3		200	None.
Taylor's Flat	Trinity	4			10,560	
Trinity Center	Coil	3				1,500
	Bowerman	13				
	Chapman & Fisher	4	3			
	Good Friday	1½	1	400 inches		
	Jacobs No. 1	2	3		250	
	Jacobs No. 2	1	4			
	Oregon Gulch	1	1			
	Patterson	1				
	Sheridan	1				
	Trinity G. M. Co	4	2	Total, 2,000 inches for 10 hours	480	
TUOLUMNE.						
Columbia	Tuolumne	125	5	Total, 1,500 inches per diem for 4 months	31,680	15,000
COLORADO.						
LAKE.						
California	Star	3	1	120,000 gallons	None.	None.
Do	Stevens & Leiter	15½	1		800	600
PARK.						
Alma township	Alma Placer	3	1	4,000,000 gallons	None.	None.
BOUTT.						
Hahn's Peak	Elk River	20			7,468	
SUMMIT.						
	Boston G. and S. M. Co	3			30	None.
	Gold Run	12			120	None.
	Sisler	2½			None.	None.
	Union French	1½			None.	None.
DAKOTA.						
CUSTER.						
Battle Creek	Battle Creek	10½	4	Total, 40,000,000 gallons	43,560	
LAWRENCE.						
Cape Horn	McKay & Ross	½			2,800	None.
Confederate	Stockade	3	1	300,000 gallons	3,960	
Whitewood	Black Hills C. and W. Co	29				2,200
PENNINGTON.						
Cañon	Last Chance	½				
Rockerville	Black Hills Placer M. Co	18			95,040	None.
GEORGIA.						
DAWSON.						
Fourth, Fifth, and Thirteenth	Anicolola and Etowah	26	2	345,576 gallons	1,200	None.
HALL.						
Twelfth	Glade	6½			2,650	None.
LUMPKIN.						
Twelfth	Dahlonega	40	2	Total, 1,000,000 gallons	2,640	5,000
Do	Hand	38	1			14,000
Do	Singleton	13	2	6,000 cubic feet	1,200	None.
UNION.						
Tenth	Coosa Creek	3			None.	None.
WHITE.						
Third	Nacoochee	9			5,280	None.
Fourth	Town Creek	5			120	1,000

TABLE LXXVII.—EXTENT OF PLANT OF MINING DITCHES REPORTED UPON IN DETAIL—Continued.

IDAHO.

County and district.	Ditch.	Total length of line, including flumes, etc.	Reservoirs. Number.	Reservoirs. Capacity.	Length of flumes.	Length of pipes.
ALTURAS.		*Miles.*			*Feet.*	*Feet.*
Elk Creek	Lisson	5	1	300 inches for 10 hours	None.	None.
BOISÉ.						
Boston	Spencer	6	2	Total, 840,000 gallons	200	None.
Moore's Creek	Alderson	16	1	875,000 gallons	3,960	None.
Do	Dunn	4			2,000	None.
Do	Christy	10			1,320	
Do	Crepisculla (feeders)	13½	2	Total, 840,000 gallons	192	None.
Do	Crepisculla (main)	16	3	Total, 1,260,000 gallons	3,500	None.
Do	Cuddy	8			800	None.
Do	East Moore's Creek	18			2,640	None.
Do	Mountain	3			225	None.
Do	Hanson	12			480	
Do	Upper Alderson	7			330	None.
Do	Plowman	16½		Direct from creek	200	876
Do	Thorn Creek	12	1	7,000 gallons	300	None.
Do	Lambing	8			1,200	None.
Pioneer	Stevenson & Noble	11½			200	None.
Do	Wilson	120	1	8,400,000 gallons	11,880	None.

MONTANA.

BEAVER HEAD.						
Bannack	Bannack D and M. Co	49½	1	500 inches	1,800	
Do	White Bar	6			10,560	
DEER LODGE.						
Henderson Gulch	Smart's Creek	13	1		1,320	
Independence	Hail Columbia	15	2		None.	
Nelson	Pioneer and Keystone	9	1		None.	
Squaw Gulch	Rock Creek	12	1		10,560	
Summit Valley	John Noyes	18			3,960	None.
LEWIS AND CLARKE.						
Last Chance	Wm. A. Cheesman	25	1	5,000,000 gallons	13,200	None.
MEAGHER.						
German	Diamond Flume and Hydraulic Co	7½			700	1,700
Thompson Gulch	Birch Creek	3	1		528	
Do	Camas Creek	2½	1			

OREGON.

BAKER.						
Blue Cañon	Littlefield & Duckworth	4	2	Total, 300 inches for 10 hours	400	None.
Do	Marysville	40	2	One, 200 inches for 24 hours One, 1,000 inches for 10 hours	500	None.
Chicken Creek	J. N. Osborne & Co	8	4	Total, 550 inches for 10 hours		
Clarksville	Placer Gold Mining Co	40	2	Total, 6,383,100 gallons	3,140	None.
Humboldt	Colt	1	4	Total, 540,000 gallons	None.	None.
Pocahontas	Baisly	2	1	100 inches for 10 hours	300	None.
Do	Jones & Carpenter	3	1	80 inches for 2 hours	None.	None.
Do	Low Cooper & Co	2½	2	Total, 150 inches for 10 hours	None.	None.
Do	Nelson	11			None.	None.
Rye Valley	Powers	20	3	Total, 700 inches for 10 hours	None.	
Shasta	Eldorado	142	6	Total, 3,105,000 gallons	6,600	
Sumter	Young & Rimbol	3½			700	None.
Willow Creek	W. Boswell	6	1	281,000 gallons		
COOS.						
	Pioneer	7			2,000	None.
DOUGLAS.						
Big Bend Cow Creek	J. G. Fuller	2	1	250,000 gallons	600	
Do	D. A. Leavens	2½			100	
Do	Merriam & Anderson	1½	3	Total, 743,000 gallons	30	None.
Do	D. F. Salmon	7	1	225,000 gallons	600	
Cañonville	Catching Bros	1½			300	None.
Do	McWilliams & Ash	2			None.	None.
Green Mountain	Charles Dwelley	2½				
Do	Dyer & Sons	1½				
GRANT.						
Cañon City	Humboldt	7½			7,920	
Do	Wolfinger's	8			13,200	
Elk Creek	Deep Creek	11	2	Total, 500 inches for 10 hours	None.	None.
Granite	Borne & Lucas	4½				
Do	J. B. Gardner's	7	1	30,296,000 gallons	None.	None.
Do	Klopp & Johnson	14½			240	1,200
Marysville	Hillis	18	1	800 inches for 12 hours	23,760	
Do	Miner's	20			13,200	
Do	Prairie Diggings	2			None.	None.
Do	Thompson's	8	2	Total, 180 inches for 12 hours	1,980	None.
Rock Creek	Lake	8	1	150 inches for 3 months	None.	None.
Do	Rock Creek	7			None.	None.

TABLE LXXVII.—EXTENT OF PLANT OF MINING DITCHES REPORTED UPON IN DETAIL—Continued.

OREGON—Continued.

County and district.	Ditch.	Total length of line, including flumes, etc.	Reservoirs.		Length of flumes.	Length of pipes.
			Number.	Capacity.		
JACKSON.		*Miles.*			*Feet.*	*Feet.*
Applegate	Grand Applegate	5			1,200	None.
Do	Squaw Lake	12½	2		2,640	None.
Ashland	Anderson & McCall	9			None.	None.
Coyote Creek	Marshall's	1½				
Do	William Rush	1½				
Farris Gulch	Farris Gulch	37½	1	33,750,000 gallons	825	600
Forty-nine	Ashland	9½			5,280	
Do	Forty-nine	17			None.	
Sam's Valley	Hays & Magruder	3½			60	
Sterling	Saltmarsh & Co	1	5	Total, 500 inches for 3½ hours	None.	
Do	Sterling	23				
Uniontown	Chapel & Co	4½	1	800 inches for 10 hours	None.	None.
Do	Gin Lin	7			None.	None.
Wolf Creek	Gross Bros	3	1	117,612,000 gallons		
JOSEPHINE.						
Grass Creek	Goff, Triplett & Chapin	6½			None.	
Do	Steam Beer	3				
Murphy	Carson & Johnson	2½	2	55,500 gallons		
Waldo	Deseelles	17			472	
Do	Waldo	8			1,200	None.
Yank	Blue Gravel	7½	1	4,500,000 gallons	1,500	
	Josephine	10			300	
WASCO.						
Ochoco	Wickaiser & Co	6	1	200 inches for 2 weeks, 10 hours a day	None.	

TABLE LXXVIII.—RECAPITULATION BY STATES AND TERRITORIES OF EXTENT OF PLANT OF MINING DITCHES REPORTED UPON IN DETAIL.

State or territory.	No. of ditch lines.	Total length, including flumes, etc.	No. of reservoirs.	Length of flumes.	Length of pipes.
		Miles.		*Feet.*	*Feet.*
Total	175	3,049½	173	715,921	205,816
Alabama	1	1		600	
Arizona	3	19	1	637	85,680
California	65	1,707	83	387,248	152,700
Colorado	8	58½	3	8,424	600
Dakota	6	61½	5	145,360	2,200
Georgia	8	140½	7	12,490	20,660
Idaho	17	286	11	29,467	876
Montana	11	160½	9	42,628	1,760
Oregon	56	615½	54	89,047	2,400

TABLE LXXIX.—ADDITIONAL PARTICULARS AS TO MINING DITCHES IN CALIFORNIA NOT INCLUDED IN THE CENSUS RETURNS.

Name.	Length.	Capacity.	Grade, per mile.	Cost.	Dimensions.		
					Top.	Bottom.	Depth.
Total	*Miles.* 498½	*Inches.* 21,500	*Feet.* 6 to 25	*Dollars.* 3,609,912	*Feet.* 5 to 9	*Feet.* 4 to 6	*Feet.* 2 to 4
North Bloomfield, including reservoirs	157	3,200	12 to 16	708,841	8½	5	3½
Milton, including reservoirs	80	3,000	12 to 25	391,579	6	4	3½
Eureka lake and Yuba	163	5,800		723,342			
Smartsville ditches		5,000	9	1,000,000	8	5	4
Hendricks	46½		6 to 12	136,150	5		2
La Grange	20	2,700	7 to 8	500,000	9	6	4
Blue Tent	32	1,800	10	150,000	8	6	4

Table LXXX gives the total length of the ditch lines of California by counties according to the official returns of the state surveyor-general, the figures for 1870, from the same source, being annexed for the purpose of comparison. The increase in the aggregate length and the decrease in the number of lines in the decade indicate a tendency toward consolidation of interests and also toward operating on a much larger scale than heretofore. In 1870 the average length per ditch was about 8½ miles; in 1880 it had increased to 12½ miles, the increase in the average being largely attributable to the construction of a few lines, each of which is greatly in excess of the present average. In this connection it may be remarked that the average length of the California ditch lines reported upon by the census agents is slightly over 26 miles, showing, as previously explained, that the deficiencies in the census returns were mainly of the minor properties.

TABLE LXXX.—NUMBER AND LENGTH OF MINING DITCHES IN CALIFORNIA IN 1880 AS COMPARED WITH 1870.

County.	1880.		1870.			County.	1880.		1870.		
	Number of ditch lines.	Length.	Number of ditch lines.	Length.	Amount of water used per day.		Number of ditch lines.	Length.	Number of ditch lines.	Length.	Amount of water used per day.
		Miles.		*Miles.*	*Inches.*			*Miles.*		*Miles.*	*Inches.*
Total	484	6,036	564	4,614	228,243	Nevada	217	824	70	946	42,400
						Placer	22	358	10	302	14,000
Amador	7	300	32	403	5,450	Plumas	34	700	.....	.....	.....
Butte	.....	600	32	190	41,000	Sacramento	2	200	2	45	4,000
Calaveras	26	525	19	515	5,800	San Bernardino	.....	.....	2	5	500
Del Norte	22	87	30	112	8,912	Shasta	28	650	.....	.....	.....
El Dorado	5	500	58	966	9,450	Sierra	55	366	49	208	21,000
Inyo	1	6	1	3	40	Siskiyou	6	250	24	290	5,010
Kern	.....	.....	2	5	1,728	Stanislaus	1	15	3	12	1,000
Klamath	.....	.....	80	90	16,000	Tehama	.....	.....	1	7	160
Lassen	3	7	.....	.....	.....	Trinity	25	400	116	340	45,773
Los Angeles	4	21	3	25	800	Tulare	1	.....	.....	.....	.....
Mariposa	.....	107	10	66	Unknown.	Tuolumne	14	190	.....	.....	.....
Mono	5	40	2	13	720	Yuba	6	100	18	69	4,500

In the absence of similar authoritative data for other portions of the country the grand total can only be approximately estimated. It may fairly be conceded that the schedules of the experts, which aimed at securing useful details of the technology of the subject rather than at mere aggregates, and which included an examination of only 1,707 miles of the more important lines in California, would show an equal ratio of deficiency in other portions of the country. If this assumption be reasonably near the truth, the total length of the ditch lines of the United States may be estimated at no less than 10,783 miles.

Of the ditches reported in the schedules the proportionate amount of fluming and pipes (exclusive of feed-pipes on hydraulic mines) is as follows:

TABLE LXXXI.—PROPORTIONATE EXTENT OF FLUMES AND PIPES IN CONNECTION WITH MINING DITCHES.

	Miles.	Percentage.
Total length of ditch lines reported in schedules	3,049.50	100.00
Total length of flumes reported in schedules	135.59	4.44
Total length of pipes reported in schedules	50.53	1.66
Total length of ditches proper reported in schedules	2,863.38	93.90

The proportion of flumes and pipes belonging to the water lines not scheduled is probably a little smaller than with the lines of more extensive equipment. It is thought safe, however, to estimate the total length of flumes at 450 miles and pipes at 150 miles, both of which are included in the general estimate of 10,783 miles, the remainder (10,183 miles) being assumed to represent the extent of the ditches proper.

California contains by far the most extensive system of artificial water channels in the United States, including six-tenths of the total length of ditch lines in the whole country. The relative importance of the California ditch lines is, however, inadequately represented by the mere standard of length, their other dimensions, capacity, more costly construction, and economic bearing placing them still higher in rank.

No general estimate can be made as to the entire amount of work which has been done in the way of ditch construction since the beginning of hydraulic mining. Thousands of miles of now idle and useless ditches were built in camps long since deserted; and in localities where placer mining is still profitably prosecuted there are also many idle ditches which have been supplanted by newer and larger ones at higher grades. As an instance in point, the case of Boisé basin, Idaho, may be cited. In this one district alone there are estimated to be no less

than 800 miles of old and abandoned ditches, which cost about $850,000, and aggregated more than double the length of the lines now in operation. Many such cases exist in California. Even a very rough approximation to the extent of these old, disused lines throughout the country is hardly practicable; but it can only be broadly stated as being very large.

COST OF PLANT.—Table LXXXII gives particulars as to the cost per yard of ditches, flumes, and pipes, and the cost of some of the reservoirs, of a number of water lines, as reported in the census schedules. There are some unexplained discrepancies in these figures; but the returns are published as received, without further comment than to call attention to the fact that while the totals seldom correspond to the sums of cost reached by comparing the average prices with the total extent of the four incomplete classes of plant named (ditches, flumes, pipes, and reservoirs), as elsewhere stated, they are more reliable than would be the sums of the items. In fact, in many instances the totals alone have been returned without an attempt to segregate the items, the latter being obtainable with greater difficulty as well as with greater uncertainty. A few of the amounts represent the prices paid by present owners, who were unable to state the original cost of the works.

TABLE LXXXII.—COST OF PLANT OF MINING DITCHES, ETC., REPORTED UPON IN DETAIL.

ALABAMA.

County and district.	Line.	Ditch per yard.	Flume per yard.	Pipe per yard.	Reservoirs.	Total cost.
CLAY.						
.....	Idaho	$0 30	$0 29	.....	.....	$380 00

ARIZONA.

MARICOPA.						
.....	Vulture Pipe Line	.....	.....	.....	.....	60,000 00

CALIFORNIA.

BUTTE.						
Cherokee	Spring Valley					417,780 00
Morris Ravine	Morris Ravine	1 25	4 00	$25 00	$120,000 00	171,153 76
Oroville	Feather River and Ophir	1 98	3 06	8 25	.....	280,000 00
CALAVERAS.						
Mokelumne Hill	Cook & Clarke	45	7 00	5 00	.....	50,000 00
.....	Mokelumne and Campo Seco	0 91 to 3 65	1 46 to 1 82	1 80 to 12 00	.....	50,000 00
.....	Union	.....	.....	.....	10,000 00	250,000 00
DEL NORTE.						
.....	Bunker Hill	3 44	2 00	.....	.....	27,000 00
.....	China Creek	.....	.....	.....	500 00	a 1,500 00
.....	Del Norte	2 25	2 25	.....	.....	100,000 00
.....	Happy Camp (south fork Indian river) ..	1 87	1 96	.....	} 10,000 00	74,000 00
.....	Happy Camp (main fork Indian river) ..	2 68	1 75	.....		
.....	Happy Camp (Grider's line)	27	2 03	.....		
.....	Mac-a-mac	32	1 70	.....	.....	5,000 00
EL DORADO.						
Georgetown	California	0 50 to 5 00	0 50 to 3 00	1 40 to 9 00	100 to 4,500 00	600,000 00
.....	El Dorado	5 50	4 50	3 50	.....	600,000 00
.....	Park Canal	1 83	2 37	3 50	60,000 00	2,100,000 00
NEVADA.						
Nevada City	South Yuba	.....	.....	.....	375,000 00	1,100,000 00
PLACER.						
Gold Run	Gold Run	.....	.....	.....	20,000 00	450,000 00
Iowa Hill	Iowa Hill	1 83	5 00	.....	8,000 00	200,000 00
PLUMAS.						
Indian Valley	Round Valley	94	3 00	.....	8,000 00	33,000 00
Seneca	Dutch Hill	.....	.....	.....	.....	325,000 00
.....	Black Hawk	20	.....	.....	1,000 00	2,524 00
.....	Hungarian Hill	72	.....	.....	4,000 00	16,000 00
.....	Plumas	72	1 50	.....	.....	50,000 00
SHASTA.						
[illegible]o	Dry Creek	.....	.....	.....	.....	120,000 00
.....	Sawmill Flat	.....	.....	.....	.....	5,000 00
SISKIYOU.						
Indian Creek	Coyote Creek	.....	75	.....	300 00	5,000 00
McAdams Creek	Hiyou Gulch	.....	50	34	100 00	3,000 00
Oro Fino	Altoona	65½	1 75	.....	.....	a 3,950 00
Do	Barker	12	1 25	.....	.....	a 1,650 00
Do	Young's (Howard ditch)	27	.....	.....	.....	6,000 00
Quartz Valley	Young's (Kidder ditch)	20	.....	.....	.....	
Do	Beaver Dam	14	.....	.....	.....	a 400 00
Scad Valley	Shackelford Creek	13	2 00	.....	.....	a 3,600 00
Do	Fort Goff	.....	.....	.....	.....	1,381 50
Yreka	Thompson Creek	29	.....	.....	.....	500 00
	Pellett & Truitt	65	.....	.....	400 00	500 00

a Cost to present owners; original cost not stated.

TABLE LXXXII.—COST OF PLANT OF MINING DITCHES, ETC., REPORTED UPON IN DETAIL—Continued.

CALIFORNIA—Continued.

County and district.	Line.	Ditch per yard.	Flume per yard.	Pipe per yard.	Reservoirs.	Total cost.
TRINITY.						
Buckeye	Buckeye				$2,500 00	$150,000 00
Hayfork	Fry Bros				500 00	15,000 00
Do	Hubbard & Edwards				1,500 00	8,500 00
Do	Hurst & Eliason					3,500 00
Do	New River					70,000 00
Do	Point Bar					20,000 00
Do	Charles Tourot					18,000 00
Indian Creek	Johnston					20,000 00
Junction City	Lewiston					16,000 00
Lewiston	Chamberlain					4,000 00
Do	Chinese Company					7,000 00
Do	Cunningham					3,500 00
Minersville	Ridgeville				1,500 00	36,000 00
Taylor's Flat	Trinity					40,000 00
Trinity Center	Coil					12,000 00
	Bowerman					7,000 00
	Chapman & Fisher				6,000 00	11,000 00
	Cañon Creek					3,500 00
	Good Friday					3,400 00
	Jacobs No. 1					5,000 00
	Jacobs No. 2					3,500 00
	Oregon Gulch					2,000 00
	Patterson					1,500 00
	Sheridan					1,000 00
	Trinity G. M. Co				8,000 00	20,000 00
TUOLUMNE.						
Columbia	Tuolumne	$4 50	$14 00	$1 00	150,500 00	300,000 00

COLORADO.

PARK.						
Alma township	Alma Placer	57			2,000 00	5,000 00
ROUTT.						
Hahn's Peak	Elk River	71	1 85			75,000 00
SUMMIT.						
	Boston G. and S. M. Co	57	7 50			a 4,000 00
	Sealer	62				a 3,000 00
	Union French					b 1,500 00

a Estimated. b Cost to present owners; original cost not stated.

DAKOTA.

CUSTER.						
Battle Creek	Battle Creek Gravel M. Co	80	3 37½		12,000 00	62,000 00
LAWRENCE.						
Cape Horn	McKay & Ross		3 00			4,000 00
Confederate	Stockade	50	50		300 00	3,000 00
Whitewood	Black Hills C. and W. Co	93		1 80		300,000 00
PENNINGTON.						
Cañon	Last Chance	33				200 00
Rockerville	Black Hills Placer Co					210,000 00

GEORGIA.

DAWSON.						
Fourth, Fifth, and Thirteenth	Anicolola and Etowah	06½	2 48		223 00	
HALL.						
Twelfth	Glade	15	5 00			6,595 00
LUMPKIN.						
Twelfth	Dahlonega	25	2 00	3 50		20,000 00
Do	Hand	10	6 00	9 00	900 00	500,000 00
Do	Singleton	17	60			
UNION.						
Tenth	Coosa Creek	09				500 00
WHITE.						
Fourth	Town Creek	40	35	2 70	100 00	5,080 00

TABLE LXXXII.—COST OF PLANT OF MINING DITCHES, ETC., REPORTED UPON IN DETAIL—Continued.

IDAHO.

County and district.	Line.	Ditch per yard.	Flume per yard.	Pipe per yard.	Reservoirs.	Total cost.
ALTURAS.						
Elk Creek	Lisson	$0 36			$600 00	$5,190 60
BOISÉ.						
Boston	Spencer	40	$5 00		200 00	4,727 60
Moore's Creek	Alderson				1,200 00	25,000 00
Do	Christy					20,000 00
Do	Crepisculla (feeders)	45	2 00		1,300 00	11,880 00
Do	Crepisculla (main)	65	2 50		2,000 00	22,497 50
Do	Cuddy					15,000 00
Do	Dunn					9,000 00
Do	East Moore's Creek					30,000 00
Do	Hanson					22,000 00
Do	Lambing	40	6 00			3,000 00
Do	Mountain					4,500 00
Do	Plowman	77	12 00	$4 65		30,000 00
Do	Thorn Creek	36	1 45			30,000 00
Do	Upper Alderson	24	2 00			a 3,000 00
Pioneer	Stevenson & Noble	98	4 00			20,000 00
Do	Wilson				2,000 00	125,000 00

a Estimated.

MONTANA.

BEAVER HEAD.						
Bannock	Bannock	55	12 50	1 15	1,000 00	
DEER LODGE.						
Henderson Gulch	Smart's Creek	60	1 10		800 00	5,000 00
Independence	Hall Columbia	90			1,000 00	20,000 00
Nelson	Pioneer and Keystone	1 50			800 00	10,000 00
Squaw Gulch	Rock Creek		10 00		1,000 00	20,000 00
Summit Valley	John Noyes	1 00	2 00			48,000 00
LEWIS AND CLARKE.						
Last Chance	Wm. A. Cheesman	1 00	5 00		10,000 00	80,000 00
MEAGHER.						
German	Diamond Flume & Hydraulic Co	6 50	4 50			90,000 00
Thompson Gulch	Birch Creek	51			700 00	1,500 00
Do	Camas	40			300 00	3,000 00

OREGON.

BAKER.						
Blue Cañon	Littlefield & Duckworth	40	37		1,500 00	4,550 00
Do	Marysville					7,500 00
Chicken Creek	J. N. Osborne & Co	50	1 60		1,300 00	8,300 00
Clarksville	Placer Gold	70	3 00		5,000 00	45,000 00
Humboldt	Colt	15			200 00	450 00
Pocahontas	Baisly	27½	2 00		400 00	4,600 00
Do	Jones & Carpenter	50			100 00	2,740 00
Do	Low, Cooper & Co	25			600 00	1,700 00
Do	Nelson	20				3,872 00
Rye Valley	Powers				5,000 00	20,488 00
Shasta	Eldorado	2 00	6 00		2,200 00	455,200 00
Sumter	Young & Rimbol	90	1 00			4,965 00
Willow Creek	W. Boswell	20			125 00	275 00
COOS.						
	Pioneer					a 15,000 00
DOUGLAS.						
Big Bend Cow Creek	J. G. Fuller	80			200 00	2,600 00
Do	D. A. Levens	27	1 00			1,100 00
Do	Merriam & Anderson	0 25 to 0 45			420 00	1,435 00
Do	D. F Salmon	50	50		150 00	6,000 00
Cañonville	Catching Bros	10½	10½			240 00
Do	McWilliams & Ash	46				1,646 00
Green Mountain	Charles Dwelley	25				730 00
GRANT.						
Cañon City	Humboldt	73	1 81			13,455 50
Do	Woltinger	63	68			12,600 00
Elk Creek	Deep Creek					16,272 00
Granite	Borne & Lucas	86				7,000 00
Do	J. B. Gardner	86			8,000 00	20,000 00
Do	Klopp & Johnson	0 22 to 0 36		1 00		10,960 00
Marysville	Hillis	82	1 82		4,000 00	40,000 00
Do	Miner's					15,000 00
Do	Prairie Diggings					1,000 00
Do	Thompson	75	1 90		8,000 00	18,320 00
Rock Creek	Lake	56			1,000 00	7,744 00

a Estimated.

TABLE LXXXII.—COST OF PLANT OF MINING DITCHES, ETC., REPORTED UPON IN DETAIL—Continued.

OREGON—Continued.

County and district.	Line.	Ditch per yard.	Flume per yard.	Pipe per yard	Reservoirs.	Total cost.
JACKSON.						
Applegate	Squaw Lake	$0 99	$4 50		$1,000 00	$25,000 00
Ashland	Anderson & McCall	25				7,000 00
Coyote Creek	Marshall	20	3 00			600 00
Do	Wm. Rush	25				700 00
Farris Gulch	Farrish Gulch (upper)	28	2 00	$1 66	1,000 00	39,868 00
Do	Farrish Gulch (lower)	90	2 00	1 66		
Forty-nine	Ashland	18	2 00			6,000 00
Do	Forty-nine (Anderson)	10				51,000 00
Do	Forty-nine (Coleman)	51				
Do	Forty-nine (Wagner)	54				
Sam's Valley	Hays & Magruder	24	3 00			1,500 00
Sterling	Saltmarsh & Co	22½				2,990 00
Do	Sterling	25	75			11,228 25
Uniontown	Chapel & Co	60			600 00	5,100 00
Do	Gin Lin	97				11,900 00
Wolf Creek	Gross Bros				100 00	300 00
JOSEPHINE.						
Grave Creek	Goff, Triplett & Chapin	30				3,500 00
Do	Steam Beer	38				2,050 00
Murphy	Carson & Johnson	45½			300 00	2,350 00
Waldo	Desselles & Co. No. 1	2 80	3 75			90,000 00
Do	Desselles & Co. No. 2	4 00	2 50			
Do	Waldo	65	2 00			10,000 00
WASCO.						
Ochoco	Wickaiser & Co	38			150 00	3,931 60

TABLE LXXXIII.—RECAPITULATION BY STATES AND TERRITORIES OF THE COST OF MINING DITCHES, ETC., REPORTED UPON IN DETAIL.

State or territory.	Number of ditch lines reporting total cost.	Corresponding number of miles.	Average cost per mile, including flumes, pipes, reservoirs, etc.	Cost.
Total	154	2,836½	$3,800 60	$10,780,414 31
Alabama	1	1	586 00	586 00
Arizona	1	16	*a* 3,750 00	60,000 00
California	60	1,667½	4,608 97	7,685,539 26
Colorado	5	30½	2,925 62	88,500 00
Dakota	6	61½	*b* 9,379 76	579,200 00
Georgia	5	92½	*c* 5,767 97	532,695 00
Idaho	16	286	1,296 28	370,735 70
Montana	9	105	2,738 10	287,500 00
Oregon	51	576½	1,779 38	1,026,258 35

a Pipe line. *b* Including an expensive flume line. *c* Including a large proportion of pipe.

From Table LXXXIII it appears that 154 ditch lines, with a total length of 2,836½ miles, cost $10,780,414 31, or an average of $3,800 60 per mile for all plant, including flumes, pipes, reservoirs, buildings, etc. The 213 miles of ditch lines reported in the schedules, without particulars as to cost, are assumed to have cost quite as much per mile as the 2,836½ miles for which the expense is specified, or $809,527 80, bringing the total cost of 3,049½ miles scheduled to $11,589,942 11. The average cost per mile of the lines not included in the experts' schedules cannot, however, be nearly so great as that of the ones which, because of special engineering difficulties, extent, or capacity were chosen for minute investigation; for although some important works unfortunately escaped the canvass of the census agents, the bulk of the lines omitted were of less costly construction than those included in the returns. Assuming an average cost of $2,000 per mile for these lines, the whole expense of building 10,783 miles (the estimated total length of ditch lines in operation) would be:

Cost of 2,836½ miles, at $3,800 60 per mile, as per schedules	$10,780,414 31
Estimated cost of 213 miles for which the schedules do not state cost, at $3,800 60 per mile	809,527 80
Estimated cost of 7,733½ miles, at $2,000 per mile	15,467,000 00
Total cost of 10,783 miles	27,056,942 11

This is exclusive of the purchase cost of water-rights, for which the aggregate amount paid is not ascertainable.

SOURCE OF WATER.—The answers received from 149 lines as to the source from which ditches receive their supply are classified in the accompanying table according to the wording of the replies. It is evident that the primal source of springs, lakes, rivers, or creeks must be either snow or rain, through whichever medium the ditches are fed; but a very noteworthy feature is the fact that only in one instance is direct rainfall alone given as the means of supply. A very large proportion of ditches head at reservoirs in creek beds or at lakes, or take their water directly from the natural channel, and in such cases the response naturally refers to the original rather than to the immediate source of the water.

TABLE LXXXIV.—SOURCE OF WATER.

State or territory.	Total number of reports.	Perennial springs.	Melted snows.	Chiefly snow.	Snow and springs.	Snow and rain.	Springs and rain.	Rain.	Lake (source unspecified).	Creek (source unspecified).
Total	149	24	23	25	54	2	18	1	1	1
Alabama	1	1	.....	.....	.....	.....	.....	.....	.....	.....
Arizona	3	1	1	.....	1	.....	.....	.....	.....	.....
California	80	1	10	.....	22	1	4	.....	.....	1
Colorado	8	3	1	.....	4	.....	.....	.....	.....	.....
Dakota	6	2	.....	.....	4	.....	.....	.....	.....	.....
Georgia	8	8	.....	.....	.....	.....	.....	.....	.....	.....
Idaho	17	.....	2	15	.....	.....	.....	.....	.....	.....
Montana	11	.....	.....	2	9	.....	.....	.....	.....	.....
Oregon	56	8	9	8	14	1	14	1	1	.....

Excluding 26 answers which do not specify whether the water came originally from rainfall or from melting snows, the following groupings may be made:

From melted snow	23	From rain and springs	18
Chiefly from snow	25	From direct rainfall alone	1
From snow and springs	54		19
	102		

Or,

	Number of answers.	Per cent.
From snow	102	82.93
From rain	19	15.45
From snow and rain	2	1.62
Total	123	100.00

While in parts of California and Oregon the gravel deposits are at comparatively low altitudes, the mean elevation of the placers of the United States, so far as reported in the census returns, is 3,447 feet above sea-level. As they are for the most part located in the foot-hills or on the flanks of high mountain ranges and in adjacent valleys, the mines receive water from original sources, which are at altitudes generally above the winter snow-line, even where the mines themselves, their ditch lines, and the tributary streams may be considerably below it. This explains the large preponderance of cases in which water is chiefly derived from the melting of snows. Of 190 hydraulic mines from which returns were received as to the immediate source of supply 173 derive their water from rivers and creeks, 2 from lakes, and 24 from various sources, such as directly from melting snow, perennial springs, etc.

Water is sometimes used a second time where the conditions will admit. Thus, of 164 answers from hydraulic mines on this head, 36 report the use, in more or less quantity, of water which had been previously employed in mining.

LENGTH OF THE WATER SEASON.—This is a very indefinite period, but in the experts' reports is taken to be the whole duration of time during which water is available, in however small amount, for mining purposes. By means of large reservoirs water may be stored in sufficient quantity to bridge over the interval between the times of rainfall, though even thus the supply gradually dwindles; and in many cases where such storage is impracticable the supply fails entirely in the dry months. When water is scanty it is often customary to economize by using it during a part of the twenty-four hours only, storing enough during the night in small reservoirs placed near the mines to suffice for a run of say ten hours or less during the day-time.

The beginning of the season in some places is with the first heavy rains, which in California seldom fall before the middle of October, and at high altitudes with the melting snows at the end of winter and in the spring. The close is determined either by drought (which may be artificially provided against) or by freezing if at high altitudes. The rainy season in California is over before the first of May. The placer districts in the territories of Idaho and Montana, which depend for water chiefly upon the melting of the snow, have consequently a season beginning later than those at comparatively low altitudes on the western side of the Sierra. This variation in altitude and in climatic conditions explains the wide divergencies in the time when the season opens, as shown in the following table, while the irregular lengths of season and the time of close depend partly upon these conditions and partly on the facilities for storing the water:

TABLE LXXXV.—MINING DITCHES—LENGTH OF WATER SEASON.

County and district.	Line.	Months during which water is supplied.	Length of water season.
			Days.
ALABAMA.			
CLAY.			
.....	Idaho	Whole year	365
ARIZONA.			
APACHE.			
Greenlee Gold Mountain	Boston	Whole year	365
MARICOPA.			
.....	Vulture Pipe Line	do	365
YAVAPAI.			
.....	Jackson	January, February, and March; in census year to May 15.	135
CALIFORNIA.			
BUTTE.			
Cherokee	Spring Valley	Whole year	365
Morris Ravine	Morris Ravine	do	365
Oroville	Feather River and Ophir	do	365
CALAVERAS.			
Mokelumne Hill	Cook & Clarke	do	365
.....	Mokelumne and Campo Seco	Whole year; in latter part of summer and beginning of fall only one-third supply.	365
.....	Union	Whole year	365
DEL NORTE.			
.....	Bunker Hill	do	365
.....	Cbina Creek	January to June 1	151
.....	Del Norte	Whole year	365
.....	Happy Camp	do	365
.....	Muc-a-muc	January to July 1	181
.....	Wingate	January to July 15	196
EL DORADO.			
Georgetown	California	Whole year	365
.....	El Dorado	Whole year, with short supply in extremely cold winters and very dry summers.	365
.....	Park Canal	Whole year	365
NEVADA.			
Nevada City	South Yuba	do	365
PLACER.			
Gold Run	Gold Run	November 15 to August 1	258
Iowa Hill	Iowa Hill	November to June	212
PLUMAS.			
Indian Valley	Round Valley	Whole year	365
Seneca	Dutch Hill	April 1 to December 1	244
Shasta	Quartz Gulch	.....	150
.....	Black Hawk	March 1 to July 1	123
.....	Hungarian Hill	March to July 15	137
.....	Plumas	April 1 to August 15	137
SHASTA.			
French Gulch	Four Ditches	Five months	150
Igo	Dry Creek	Seven or eight months	235
SISKIYOU.			
Indian Creek	Bay City	March 1 to June 1	92
Do	Coyote Creek	February 1 to May 15	104
McAdams Creek	Hiyou Gulch	February 1 to June 1	120
Oro Fino	Altoona	March to July 1	123
Do	Barker	Whole year	365
Do	Wright & Fletcher	February 1 to July 1	150
Do	Young's	do	150
Quartz Valley	Beaver Dam	Whole year	365
Do	Shackelford Creek	March 1 to July 1	123
Sciad Valley	Fort Goff	November to July	243
Do	Thompson Creek	Whole year	316
Yreka	Pellett & Truitt	December to July	333

TABLE LXXXV.—MINING DITCHES—LENGTH OF WATER SEASON—Continued.

CALIFORNIA—Continued.

County and district.	Line.	Months during which water is supplied.	Length of water season.
			Days.
TRINITY.			
Hayfork	Hubbard & Edwards	Four months	120
Do	Hurst & Ellason	Three months	90
Do	Point Bar	do	90
Do	Tourot	Four months and 25 days	145
Indian Creek	Johnston	January to July	181
Junction City	Lewiston	December to September	274
Taylor's Flat	Trinity	Nine to ten months	295
Trinity Center	Chapman & Fisher	January to August 1	212
	Trinity G. M. Co	November to August 1	273
TUOLUMNE.			
Columbia	Tuolumne	Ten months	300

COLORADO.

LAKE.			
California	Star	June, July, and August	92
Do	Stevens & Leiter	May, June, July, August, and September	153
PARK.			
Alma township	Alma Placer	May 1 to October 1	153
ROUTT.			
Hahn's Peak	Elk River	May 1 to September 15	138
SUMMIT.			
	Boston G. and S. M. Co	May to October	153
	Gold Run	May to November	184
	Sisler	May to October	153
	Union French	May to November 15	199

DAKOTA.

CUSTER.			
Battle Creek	Battle Creek Gravel M. Co	April 1 to November 1	214
LAWRENCE.			
Cape Horn	McKay & Ross	March to November	245
Confederate	Stockade	do	245
Whitewood	Black Hills C. and W. Co	Whole year	365
PENNINGTON.			
Calion	Last Chance	April 1 to December 1	244
Rockerville	Black Hills Placer Co	March to December 1	275

GEORGIA.

DAWSON.			
Fourth, Fifth, and Thirteenth	Amicalola and Etowah	Whole year	365
HALL.			
Twelfth	Glade	do	365
LUMPKIN.			
Twelfth	Dahlonega	do	365
Do	Hand	do	365
Do	Singleton	do	365
UNION.			
Tenth	Coosa Creek	do	365
WHITE.			
Third	Nacoochee	do	365
Fourth	Town Creek	do	365

IDAHO.

ALTURAS.			
Elk Creek	Lisson	April 26 to November 1	189
BOISÉ.			
Boston	Spencer	March 20 to July 1	103
Moore's Creek	Alderson	April 1 to November 1	214
Do	Christy	do	214
Do	Crepisculla (feeders)	March 20 to August 1	134
Do	Crepiscullia (main)	do	134
Do	Caddy	April 1 to November 1	214
Do	Dunn	April 1 to July 15	106
Do	East Moore's Creek	April 15 to November 15	215
Do	Hanson	April 15 to August 1	108
Do	Lambing	March 15 to July 15	122

TABLE LXXXV.—MINING DITCHES—LENGTH OF WATER SEASON—Continued.

IDAHO—Continued.

County and district.	Line.	Months during which water is supplied.	Length of water season.
BOISE—continued.			Days.
Moore's Creek	Mountain	April 30 to August 1	93
Do	Plowman	March 15 to July 15	123
Do	Thorn Creek	April 24 to July 31	99
Do	Upper Alderson	April 1 to November 1	214
Pioneer	Stevenson & Noble	May 1 to September 3	126
Do	Wilson	April 15 to November 1	200

MONTANA.

BEAVER HEAD.			
Bannock	Bannock	May to October	153
Do	White Bar	June to October	122
DEER LODGE.			
Independence	Hail Columbia	April to October	183
Nelson	Pioneer and Keystone	May 1 to November 1	184
Summit Valley	John Noyes	May to August	92
LEWIS AND CLARKE.			
Last Chance	Wm. A. Cheesman	April to November	92
MEAGHER.			
Thompson Gulch	Camas	June to October	122

OREGON.

BAKER.			
Blue Cañon	Littlefield & Duckworth	April 1 to November 1	214
Do	Marysville	do	214
Chicken Creek	J. N. Osborne & Co	April to August	123
Clarksville	Placer Gold	March 1 to December 1; short supply after July 1.	275
Humboldt	Colt	March to May	61
Pocahontas	Baisly	April to November	214
Do	Jones & Carpenter	April 1 to November 1	214
Do	Lew Cooper & Co	April 1 to September 1	153
Do	Nelson	do	153
Rye Valley	Powers	April 1 to November 1	214
Shasta	Eldorado	May 1 to November 20	204
Sumter	Young & Rimbol	April 1 to September 1	183
Willow Creek	W. Boswell	February to May	89
COOS.			
	Pioneer	October to May	212
DOUGLAS.			
Big Bend Cow Creek	J. G. Fuller	December to June	183
Do	D. A. Levens	do	183
Do	Merriam & Anderson	December to April 1	121
Do	D. F. Salmon	December to May	151
Cañonville	Catching Bros	do	151
Do	McWilliams & Ash	December to April	121
Green Mountain	Charles Dwelley	December to May	151
Do	Dyer & Son	do	151
GRANT.			
Cañon City	Humboldt	April 1 to December 1	244
Granite	Borne & Lucas	April 1 to September 1	153
Do	J. B. Gardner	April 1 to August 15	137
Do	Klepp & Johnson	April 1 to September 15	168
Marysville	Prairie Diggings	April to June	61
Do	Thompson	February to December	306
JACKSON.			
Applegate	Squaw Lake	Whole year	365
Coyote Creek	Marshall	December 1 to March 1	90
Do	Wm. Rush	December 1 to July	212
Farris Gulch	Farris Gulch	February to August 15	196
Forty-nine	Ashland	do	196
Do	Forty-nine	February to June	120
Sam's Valley	Hays & Magruder	December to May	151
Wolf Creek	Grass Bros	December to June	182
JOSEPHINE.			
Grass Creek	Goff, Triplett & Chapin	do	182
Do	Steam Beer	December to May	151
Murphy	Carson & Johnson	December to June	182
Waldo	Deselles & Co	February to August	181
Do	Waldo	December 1 to July 1	212
Yank	Blue Gravel	November to August	273
	Josephine	December to June	183
WASCO.			
Ochoco	Wickaiser & Co	November to June	212

The data given in the foregoing list are summarized by states and territories in Table LXXXVI, from which it appears that reports from 142 water lines give a general average of 211½ days, with a range between an average of 135½ days in Montana and a continuous supply in Georgia. Regarding these results, two essential qualifications should be noted: First, that the averages are computed solely from the limited schedule data; and second, that as the investigation included mainly the more important lines, the probabilities are that considerably higher averages are obtained than would be the case were all the lesser lines taken into account.

TABLE LXXXVI.—MINING DITCHES—AVERAGE LENGTH OF WATER SEASON.

State or territory.	Number of ditch lines reporting length of season.	Average number of days.
Total	142	211½
Alabama	1	365
Arizona	3	298½
California	48	242½
Colorado	8	153½
Dakota	6	204½
Georgia	3	365
Idaho	17	163½
Montana	7	135½
Oregon	44	178½

CAPACITY OF MINING DITCHES.—The amount of water delivered by 173 lines upon which reports were made is 184,088,958 gallons per hour, corresponding to 262,984 miner's inches, and it is presumed that the figures reported in the majority of cases are of the maximum capacity, not the actual average delivery of the several lines. The average delivery per ditch of these lines in the height of the season is 1,064,098 gallons per hour, or 1,520 miner's inches. For the whole number of ditch lines in operation in the United States, including ditches not reported upon, the maximum capacity is estimated at not less than 450,000 inches, or 315,000,000 gallons per hour and 7,560,000,000 gallons per 24 hours. This is about eighty times the capacity of the Croton aqueduct, which supplies New York city with water. The amount of water actually delivered is, however, very variable, and the average during the season is far below the maximum capacity of the ditches.

Table LXXXVII gives the amount of water used in mining in the Sacramento and San Joaquin basin, California, in 1880 and discharged into the river beds, expressed in terms of 24-hour miner's inches. The figures are from the county assessor's returns, supplemented by data furnished by the state engineer department and by information collected by Lieutenant Payson, United States engineer corps, as published in the report of Lieutenant-Colonel Mendell on *Mining Débris in California Rivers* (page 16). Taking the miner's inch at 2,250 cubic feet per 24 hours, the total quantity used in this region represents a sheet of water 37½ miles long, 3 miles wide, and 10 feet deep.

TABLE LXXXVII.—QUANTITY OF WATER USED IN MINING IN THE SACRAMENTO AND SAN JOAQUIN BASIN IN 1880.

Name of stream.	Twenty-four hour miner's inches.
Total	14,034,985
Table Mountain, or Dry creek	833,250
Butte creek	24,000
Feather river	1,259,363
Yuba river	5,456,171
Bear river	1,117,082
Dry creek No. 2	44,229
American river	1,914,500
Cosumnes river	504,000
Dry creek	102,000
Mule creek	38,000
Sutter creek	457,750
Jackson creek	171,150
Mokelumne river	234,500
Calaveras river	975,750
Stanislaus river	36,720
Tuolumne river	813,500

LEAKAGE AND EVAPORATION.—Replies from owners of 62 ditch lines as to the amount of water lost in transit through the ditches show that the average amount believed to be lost by leakage is 7.40 per cent., and by evaporation 9.06 per cent., of the quantity actually delivered. The statements selected in making this computation were those in which the losses by both leakage and evaporation were specifically stated, and many of the answers gave the total supposed loss, but did not discriminate as to the cause. While these results have not the weight of careful experiment, they represent the current opinion of well-informed persons. With well-built and established lines the loss by leakage is usually very small, though new lines, cut in light soil, are apt to leak badly for a time until their walls have thoroughly settled and the bad spots have been strengthened. Evaporation depends upon the length of the line; that is, the time during which the water is exposed in transit; upon the location of the ditch, whether on the north or the south slopes of the hills, and whether shaded or partially shaded by timber; upon the climate and season, the latitude and the altitude, and upon the porosity of the ditch banks. The earth at the sides of the ditches acts as a sponge, absorbing water and by capillary attraction bringing it under the influence of the sun's rays, thus increasing the exposed water area. It is therefore not remarkable that the loss by evaporation should as a general average exceed that by leakage, though in particular cases the circumstances are reversed. The variation according to season is naturally very marked, not only because of the difference in intensity of the solar heat, but also because of the difference in humidity of earth and air in the rainy and the dry portions of the year. The average total loss by both leakage and evaporation is 16.46 per cent., calculated upon the amount of water delivered. Table LXXXVIII gives the delivery and the loss of a number of specimen ditches.

TABLE LXXXVIII.—QUANTITY OF WATER DELIVERED BY SPECIMEN MINING DITCHES AND LOSS BY LEAKAGE AND EVAPORATION.

County and district.	Line.	Quantity of water delivered per hour.	Quantity lost by leakage.	Quantity lost by evaporation.	Total quantity lost.
ARIZONA.					
APACHE.		*Gallons.*	*Per cent.*	*Per cent.*	*Per cent.*
Greenlee Gold Mountain	Boston	300,000	6.66	16.67	23.33
CALIFORNIA.					
BUTTE.					
Oroville	Feather River and Ophir	1,750,000	4	8	12
CALAVERAS.					
Mokelumne Hill	Cook & Clarke	1,260,000	20	15	35
	Mokelumne and Campo Seco	700,000	2	10	12
	Union	1,750,000	3	10 to 25	13 to 28
DEL NORTE.					
	Del Norte	1,200,000	16.66	16.67	33.33
	Happy Camp	3,283,200	8	12	20
EL DORADO.					
Georgetown	California	3,400,000	5 to 10	20 to 30	25 to 40
	El Dorado	2,800,000	15 to 20	20	35 to 40
	Park Canal	1,540,000	5	15 to 20	20 to 25
PLACER.					
Gold Run	Gold Run	1,505,000	10	8	18
SISKIYOU.					
Indian Creek	Bay City	504,000	10	10	20
Do	Coyote Creek	1,186,920	10	20	30
Oro Fino	Altoona	630,000	.....	10	10
Do	Barker	490,000	10	10	20
Do	Wright & Fletcher	3,150,000	Very slight.	10	.....
Do	Young's	3,110,400	Very slight.	10	.....
Quartz Valley	Beaver Dam	560,000	Very slight.	5	.....
Do	Shackelford Creek	1,400,000	.....	10	.....
Scad Valley	Thompson Creek	1,009,200	5	5	10
TRINITY.					
	Trinity G. M. Co	1,400,000	1.5	1.5	3
TUOLUMNE.					
Columbia	Tuolumne	2,100,000	5	15	20

TABLE LXXXVIII.—QUANTITY OF WATER DELIVERED BY SPECIMEN MINING DITCHES, ETC.—Continued.

COLORADO.

County and district.	Line.	Quantity of water delivered per hour.	Quantity lost by leakage.	Quantity lost by evaporation.	Total quantity lost.
LAKE.		*Gallons.*	*Per cent.*	*Per cent.*	*Per cent.*
California	Star	846,000	1.4		
Do	Stevens & Leiter	2,880,000	10		
PARK.					
Alma township	Alma Placer	275,000	12	9	21
ROUTT.					
Hahn's Peak	Elk River	1,400,000	5	8	13
SUMMIT.					
	Boston G. and S. M. Co	700,000	10		
	Gold Run	700,000	3	8	11
	Sisler	196,000	10	8	18
	Union French	216,000	6	8	14

DAKOTA.

CUSTER.					
Battle Creek	Battle Creek Gravel M. Co	472,500	3	1	4
LAWRENCE.					
Cape Horn	McKay & Ross	210,000	5		
Confederate	Stockade	280,000	10	1	11
Whitewood	Black Hills C. and W. Co	196,700	5.5		
PENNINGTON.					
Cañon	Last Chance	25,000	1	0.25	1.25
Rockerville	Black Hills Placer Co	1,400,000	5	1	6

GEORGIA.

HALL.					
Twelfth	Glade	560,000	10		
LUMPKIN.					
Twelfth	Dahlonega	196,447	12.50	25	37.50
Do	Hand	1,022,694			
Do	Singleton	196,447	10	10	20
WHITE.					
Fourth	Town Creek	359,214			25

IDAHO.

BOISÉ.					
Boston	Spencer	280,000			10
Moore's Creek	Alderson	700,000	5		
Do	Christy	560,000			6.25
Do	Crepisculla (feeders)	630,000			6
Do	Crepisculla (main)	560,000	2.50	2.50	5
Do	Cuddy	280,000	5	7 to 8	12 to 13
Do	Dunn	280,000			6.25
Do	East Moore's Creek	700,000			6
Do	Hanson	700,000			3
Do	Lambing	700,000	6	3	9
Do	Mountain	210,000			35
Do	Plowman	490,000	5.75	2.87	8.62
Do	Thorn Creek	700,000			10
Do	Upper Alderson	210,000	3.33	5	8.33
Pioneer	Stevenson & Noble	2,800,000		4	
Do	Wilson	3,150,000			15

MONTANA.

BEAVER HEAD.					
Bannock	Bannock	9,100,000	10	6	16
Do	White Bar	280,000	5	1	6
DEER LODGE.					
Henderson Gulch	Smart's Creek	560,000		10	
Independence	Hail Columbia	175,000		16.67	
Squaw Gulch	Rock Creek	1,050,000	10		
Summit Valley	John Noyes	490,000			10
LEWIS AND CLARKE.					
Last Chance	Wm. A. Cheesman	1,050,000	10	5	15
MEAGHER.					
German	Diamond Flume and Hydraulic Co	1,750,000	10		
Thompson's Gulch	Birch Creek	175,000	8	8	16

TABLE LXXXVIII.—QUANTITY OF WATER DELIVERED BY SPECIMEN MINING DITCHES, ETC.—Continued.

OREGON.

County and district.	Line.	Quantity of water delivered per hour.	Quantity lost by leakage.	Quantity lost by evaporation.	Total quantity lost.
BAKER.		*Gallons.*	*Per cent.*	*Per cent.*	*Per cent.*
Blue Cañon	Littlefield & Duckworth	280,000	1.25	1.25	2.50
Do	Marysville	700,000	20	5	25
Chicken Creek	J. N. Osborne & Co	210,000	10	50	60
Clarkeville	Placer Gold	1,120,000	15.63	12.50	28.13
Humboldt	Colt	210,000	2		
Pocahontas	Baisly	420,000	3.33	1.67	5
Do	Jones & Carpenter	420,000	2.50	0.83	3.33
Do	Lew Cooper & Co	175,000	10	8	18
Do	Nelson	490,000	5.75	1.42	7.17
Rye Valley	Powers	770,000	4.55	6.82	11.37
Shasta	Eldorado	826,000	20	13	33
Sumter	Young & Rimbol	700,000	3	1	4
Willow Creek	W. Boswell	140,000	1.50		
DOUGLAS.					
Big Bend Cow Creek	J. G. Fuller	1,050,000	10		
Do	D. A. Leavens	834,400	20		
Do	D. F. Salmon	1,176,000	33⅓		
Cañonville	Catchings Bros	371,800	20		
Green Mountain	Charles Dwelley	9,000,000	10		
GRANT.					
Cañon City	Humboldt	700,000	5	5	10
Granite	Borne & Lucas	420,000	8.33		
Do	J. B. Gardner	980,000	2.14	0.71	2.85
Do	Klopp & Johnson	1,050,000	8.33		
Marysville	Hillis	560,000	3.12	5	8.12
Do	Miner's	210,000	8.33	16.67	25
Do	Prairie Diggings	350,000	4	2	6
Do	Thompson	525,000	3.33	5.33	8.66
Rock Creek	Lake	175,000	4	10	14
JACKSON.					
Applegate	Squaw Lake	700,000	5	15	20
Sam's Valley	Hays & Magruder	324,000		10	
Sterling	Sterling	1,260,000	11.11	22.22	33.33
Uniontown	Gin Lin	1,400,000	3	2	5
JOSEPHINE.					
Waldo	Desselles & Co	2,494,800	6.25	6.25	12.50
Do	Waldo	1,458,000	5	5	10
Yank	Blue Gravel	1,620,000	15	10	25
WASCO.					
Ochoco	Wickaiser & Co	140,000	12.50	7.50	20

GRADE OF DITCHES.—The grade of the larger ditches ranges from 9 to 20 feet per mile, with exceptional higher grades. If the ditches are built in light soil, the grades are necessarily low; but where the ground is firm and tenacious the present tendency is to increase the grade, thus giving a more rapid current, and consequently greater capacity in proportion to the cross-section of the ditch. It is evident that, the less the time occupied in transit, the less is the proportionate amount of leakage and evaporation; and, besides this, it is found that narrow, deep, and comparatively steep ditches are less liable to damage by storms and are more readily repaired. Grades of 16 to 20 feet are now recommended by some engineers for lines cut in good ground.

The gradient is expressed either in inches and fractions of inches per rod or in feet per mile, the latter mode of expression being adopted in this discussion. For convenient reference the following conversion table, giving the equivalents in the two systems, is annexed:

TABLE LXXXIX.—GRADE EQUIVALENTS.

Inches per rod	⅛	¼	⅜	½	⅝	¾	⅞	1
Feet per mile	3⅛	6¼	10	13¼	16½	20	23¼	26⅜

Inches per rod	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2
Feet per mile	30	33⅛	36¾	40	43½	46⅝	50	53⅛

VELOCITY OF CURRENT.—The velocity of water in the ditches is from 1½ miles per hour in the lines of least grade up to 5 miles per hour in the steepest ditches. The average current is slightly over 3 miles per hour.

DIMENSIONS.—The cross-section of ditches is trapezoidal, the width at the top being considerably greater than that at the bottom, though the newer ditches are cut with less slope to the banks than was formerly the rule, as well as deeper in proportion to the width. Table XC gives the grade and the dimensions of specimen ditches.

TABLE XC.—GRADE AND DIMENSIONS OF MINING DITCHES.

ALABAMA.

County and district.	Ditch.	Grade.	Width at top.	Width at bottom.	Depth.
CLAY.		*Feet per mile.*	*Feet.*	*Feet.*	*Feet.*
	Idaho	13½	2	1½	1½

ARIZONA.

APACHE.					
Greenlee Gold Mountain	Boston	13	5	2½	2½

CALIFORNIA.

BUTTE.					
Cherokee	Spring Valley	12	9	6	3½
Morris Ravine	Morris Ravine	9		5	3
Oroville	Feather River and Ophir	11	9	6	3
CALAVERAS.					
Mokelumne Hill	Cook & Clarke	13	3	2½	1½
	Mokelumne and Campo Seco	12	9	6	2
	Union	20 to 25			
DEL NORTE.					
	Bunker Hill	13½	5	4	2
	China Creek No. 1	13½	4	2½	1½
	China Creek No. 2	13½	3½	2	1½
	China Creek No. 3	13½	3½	1½	1½
	China Creek No. 4	13½	6	4	2
	China Creek No. 5	13½	6	4	2
	Del Norte		6 to 9	5 to 8	
	Happy Camp No. 1	13½	6	5	2
	Happy Camp No. 2	13½	6	5	2½
	Happy Camp No. 3	13½	5	4	1½
	Muc-a-muc	16½	4½	2½	1½
	Wingate No. 1	13½	3	2	1½
	Wingate No. 2	13½	3	2½	1½
	Wingate No. 3	13½	5	4	2
EL DORADO.					
Georgetown	California	6 to 16	3½ to 8	2 to 5	1½ to 3
	El Dorado	4	10	6	4
	Park Canal		8	5	2½
NEVADA.					
Nevada City	South Yuba	8 to 12	6		4 to 5
PLACER.					
Gold Run	Gold Run	26	6	4	2½
Iowa Hill	Iowa Hill	10	10	7	4½
PLUMAS.					
Indian Valley	Round Valley	10	4	2	3
Seneca	Dutch Hill	40	6	3	3
	Black Hawk	Irregular.	3	1½	1½
	Hungarian Hill	12	6	2½	2½
	Pinmas	13½	7	5	3½
SHASTA.					
Igo	Dry Creek	6			
SISKIYOU.					
Indian Creek	Bay City No. 1	13½	2	1½	1½
Do	Bay City No. 2	13½	3	2	1½
Do	Coyote Creek No. 1	13½	2	1½	1½
Do	Coyote Creek No. 2	13½	3	2	1½
Do	Coyote Creek No. 3	13½	4½	3	2
McAdams Creek	Hiyou Gulch No. 1	13½	3	2	2
Do	Hiyou Gulch No. 2	13½	1½	1	1
Oro Fino	Altoona	16½	6	4	2½
Do	Barker	6½	5	3	3
Do	Wright & Fletcher	13½	10	8	3
Do	Young's No. 1	13½	6	3½	2½
Do	Young's No. 2	13½	10	7	3
Quartz Valley	Beaver Dam	6½	5	2½	2
Do	Shackelford Creek	6½	7	5	4
Scad Valley	Fort Goff No. 1	26½	4	3	2
Do	Fort Goff No. 2	26½	6	4	3
Do	Thompson Creek	13½	5	4	3
Yreka	Pellett & Truitt No. 1	6½	5	3	2
Do	Pellett & Truitt No. 2	6½	3	2	1
Do	Pellett & Truitt No. 3	6½	3	2	1
TRINITY.					
Buckeye	Buckeye	10	5	3	3
Hayfork	New River	9			
Indian Creek	Johnston	10	5½	4½	3
Junction City	Lewiston		5	3	3
Minersville	Ridgeville	26½ to 40			
Taylor's Flat	Trinity	10	7	5	2½

TABLE XC.—GRADE AND DIMENSIONS OF MINING DITCHES—Continued.

CALIFORNIA—Continued.

County and district.	Ditch.	Grade.	Width at top.	Width at bottom.	Depth.
		Feet per mile.	*Feet.*	*Feet.*	*Feet.*
TRINITY—continued.					
	Chapman & Fisher	13½			
	Trinity G. M. Co	11½	7	4	3
TUOLUMNE.					
Columbia	Tuolumne	11 to 22	11 to 15	7½ to 11	4
COLORADO.					
LAKE.					
California	Star	Irregular.			
Do	Stevens & Leiter	5	10	7	3
PARK.					
Alma township	Alma Placer	6½	6 to 8		1½
ROUTT.					
Hahn's Peak	Elk River	10	4	3	2½
SUMMIT.					
	Boston G. and S. M. Co	7	2½		1½
	Gold Run	6½	2½		2
	Sisler	6 to 8	3		1½
	Union French	6½	4		1½
DAKOTA.					
CUSTER.					
Battle Creek	Battle Creek Gravel M. Co	6½			
LAWRENCE.					
Cape Horn	McKay & Ross	27½	3		1½
Confederate	Stockade	3½			
Whitewood	Black Hills C. and W. Co	13½ to 27½			
PENNINGTON.					
Caton	Last Chance	6½			
GEORGIA.					
DAWSON.					
Fourth, Fifth, and Thirteenth	Anicolola and Etowah (main)	4	6	5	3
Do	Anicolola and Etowah (others)	4	3	2½	2
HALL.					
Twelfth	Glade	4½			
LUMPKIN.					
Twelfth	Dahlonega	4	3	2	2½
Do	Hand No. 1	4	6	5	3
Do	Hand No. 2	4	5	4	3
Do	Singleton	4	5	3	1½
UNION.					
Tenth	Coosa Creek		3	2	3
WHITE.					
Third	Nacoochee	5	5	3	3
Fourth	Town Creek	5	4	3	3
IDAHO.					
ALTURAS.					
Elk Creek	Lisson	13½	3½	2	2½
BOISÉ.					
Boston	Spencer	16½	4½	3	2½
Moore's Creek	Alderson	16½	4	3	2
Do	Dunn	13½	4	3	2
Do	Christy	10	5½	4	2
Do	Crepisculla (feeders)	10	3 to 4	2 to 3	2
Do	Crepisculla (main)	6½ to 10	3 to 4	2 to 3	2
Do	Cuddy	16½	3½	2½	2
Do	East Moore's Creek	10	5 to 5½	3 to 4	2
Do	Hanson (upper)	10	4	3	2
Do	Hanson (lower)	10	5½	4	2
Do	Lambing	10	6	4	2½
Do	Mountain	13½	4	3	2
Do	Plowman	10 to 13½	5	3½	2
Do	Thorn Creek	10 to 13½	6	3½	2
Do	Upper Alderson	13½	5	2½ to 3	2
Pioneer	Stevenson & Noble No. 1	26½	6	4	3
Do	Stevenson & Noble (others)	13½	3½	2	2
Do	Wilson No. 1	10 to 13½	8½	6	3
Do	Wilson (others)	10 to 13½	5½	4	3

TABLE XC.—GRADE AND DIMENSIONS OF MINING DITCHES—Continued.

MONTANA.

County and district.	Ditch.	Grade.	Width at top.	Width at bottom.	Depth.
		Feet per mile.	*Feet.*	*Feet.*	*Feet.*
BEAVER HEAD.					
Bannock	Bannock D. and M. Co	8	5	4	2½
Do	White Bar	6½	5	3	1½
DEER LODGE.					
Henderson Gulch	Smart's Creek	6½	7	5	2
Independence	Hail Columbia	8			
Nelson	Pioneer and Keystone	13½ to 16½	4		2½
Squaw Gulch	Rock Creek	10	7		3½
Summit Valley	John Noyes	13½			
LEWIS AND CLARKE.					
Last Chance	William A. Cheesman No. 1	5	7	4	2
Do	William A. Cheesman No. 2	5	8½	5	2½
MEAGHER.					
Gorman	Diamond Flume and Hydraulic Co	13½	7	5	3½
Thompson Gulch	Birch Creek	20	2½	1½	1½
Do	Camas Creek	13½	3	1½	1½

OREGON.

BAKER.					
Blue Cañon	Littlefield & Duckworth	13½	3	2	2
Do	Marysville	13½	5	3	2
Chicken Creek	J. N. Osborne & Co	6½	3	2	1½
Clarksville	Placer Gold M. Co. No. 1	6½	6	4	2
Do	Placer Gold M. Co. No. 2	20	8	4½	2½
Humboldt	Colt	26½	2	1½	1½
Pocahontas	Baisly	20	5	4	1½
Do	Jones and Carpenter (upper)	33½	2½	2	1½
Do	Jones and Carpenter (lower)	33½	5	3	2½
Do	Lew Cooper & Co	13½	1½	1½	1
Do	Nelson	20	6	4	3
Rye Valley	Powers	13½	4	2	2
Shasta	Eldorado (main)	6 to 12	7	5	2
Do	Eldorado (others)	6 to 13	2 to 2½	1½	1 to 1½
Sumter	Young & Rimbol	9½	4½	4	2
Willow Creek	W. Boswell	6½	3	1½	1½
COOS.					
	Pioneer	7½	4	3	3
DOUGLAS.					
Big Bend Cow Creek	J. G. Fullers (new)	17½	3	2	2
Do	J. G. Fullers (old)		2	1	1½
Do	D. A. Leavens (upper)	13½	3	2	2
Do	D. A. Leavens (lower)	13½	3	1½	1½
Do	Merriam & Anderson	13½	3	2½	2
Do	D. F. Salmon (main)	10	3½	2½	2
Do	D. F. Salmon (others)	13½	2	1½	1½
Cañonville	Catching Brothers	13½	3		
Do	McWilliams & Ash	6½	3½	2½	1½
Green Mountain	Charles Dwelley	20	3	1½	1½
Do	Dyer & Sons	20	2	1½	1½
GRANT.					
Cañon City	Humboldt	20	3	2	2
Do	Wolfinger's	6½	6	4	2
Elk Creek	Deep Creek	13½	4	2½	1½
Granite	Borne & Lucas (main)	40	4	3	2
Do	Borne & Lucas (others)	40	2½	2	1½
Do	J. B. Gardner's (main)	13½	5	4	1½
Do	J. B. Gardner's (small)	13½	2	1½	1½
Do	Klopp & Johnson (main)	13½	5	4	2
Do	Klopp & Johnson (others)	13½	3	2	1½
Marysville	Hillis	5½	12	6	7
Do	Miner's	5½	6	3	2½
Do	Prairie Diggings	26½	4	3	1½
Do	Thompson's	45½	4	3	1½
Rock Creek	Lake	10	5	3	2
Do	Rock Creek	27½	4	3	2
JACKSON.					
Applegate	Grand Applegate	20	6	3	2
Do	Squaw Lake	13½	5	3	2½
Ashland	Anderson & McCall	20	3	2	2
Coyote Creek	Marshall's	20	2½	1½	2
Do	William Rush	17½	2½	1½	1½
Farris Gulch	Farris Gulch (upper)	13½	4	2½	2
Do	Farris Gulch (lower)	10	5½	2½	2½
Forty-nine	Ashland	20	7	3	2
Do	Forty-nine (Coleman)	26½	5	1½	2
Do	Forty-nine (Anderson)	20	4	2	1½
Do	Forty-nine (Wagner)	13½	5	3	2
Sam's Valley	Hays & Magruder	6½	3	2	1½
Sterling	Saltmarsh & Co	6½	3	1½	1½
Do	Sterling	13½	5	4	3
Uniontown	Chapel & Co	13	3	2½	2
Do	Gin Lin	13½	6	3	2½
Wolf Creek	Gross Brothers	20	3	2	1½

TABLE XC.—GRADE AND DIMENSIONS OF MINING DITCHES—Continued.

OREGON—Continued.

County and district.	Ditch.	Grade.	Width at top.	Width at bottom.	Depth.
JOSEPHINE.		Feet per mile.	Feet.	Feet.	Feet.
Grass Creek	Goff, Triplett & Chapin No. 1	264	3	2	1½
Do	Goff, Triplett & Chapin No. 2	264	3		1½
Do	Steam Beer	105	3½	3	2
Murphy	Carson & Johnson	132	3½	3	1
Waldo	Desselles No. 1	132	6	4	3
Do	Desselles No. 2	132	3½	3	2
Do	Waldo (main)	6	7	5	3
Do	Waldo (pipe ditch)	6	3½	2½	2
Do	Waldo (waste-water ditch)	6	7	5	2½
Yank	Blue Gravel	20	5	3	3
	Josephine No. 1	132	5	4	3
	Josephine No. 2	132	4½	3	2
WASCO.					
Ochoco	Wiekaiser & Co	132	2	1½	1½

LINING OF DITCHES.—Under ordinary circumstances it is not customary or necessary to add a lining or facing of any kind, the fine silt held in suspension by the water of the ditch forming in time without artificial puddling (though this is sometimes resorted to) a clayey covering on the inner surfaces sufficiently impermeable for practical purposes. It is from this cause that, within reasonable limits and with proper repairs, the carrying capacity increases considerably with the age of the ditch, the loss from leakage gradually diminishing. This result is also furthered by the settling of the earth of the outer embankment, which, as it becomes more compact, is less liable to leakage and at the same time presents a better surface for the flow of water.

In following the contours of the hill-sides, to maintain a constant grade without resorting to the expedient of flumes, sharp turns are often unavoidable, as in crossing the head of ravines or in rounding a sharply projecting flank of the hill. It is at such points that eddies are formed and the greatest exposure occurs. If the embankment is here in danger of being washed out, it may be protected by cribbing with timber and logs or by facing with stone or boards at the salients. After a new ditch has been in operation a short time these weak spots manifest themselves and are fortified as occasion demands, the whole line being under very careful scrutiny until its permanence is established. At re-entering angles threatened with damage by small water channels crossing the line of the ditch the indications given in advance of construction are usually plain enough to cause suitable precaution to be taken, as by throwing a single box or two of fluming over the exposed point and deepening the natural channel beneath, etc. When it is possible, these side waters are, of course, turned directly into the ditch, to add to its contents and offset the loss from leakage or evaporation, care being taken to bring the confluents in at easy angles and to protect the outer bank from the impinging cross-currents. The experienced ditch builder utilizes these advantages or avoids the dangers as if by instinct.

In order to ascertain roughly the proportionate number of cases in which linings are used, questions to this effect were incorporated in the experts' schedules. From the following list it appears that, out of 139 answers received, only 11 ditch lines were reported to be lined to an extent worth noting, and in but two cases was the lining of any great extent:

TABLE XCI.—LINING OF DITCHES.

State or territory.	Answers received.	Ditches lined to some extent.	Ditches partially lined.	Ditches not lined.
Total	139	3	8	128
Alabama	1			1
Arizona	1			1
California	40	2	2	36
Colorado	7		1	6
Dakota	4	1		3
Georgia	8		1	7
Idaho	17		1	16
Montana	11		2	9
Oregon	50		1	49

As a general rule, it is cheaper to put in short lengths of ground flume at the worst points than to attempt to secure them by linings. It is this view of the case which has led the constructors of recent ditches to abandon lining in most instances, except where defects are noticed after the ditches have been running for some time and linings are put in as make-shifts. Typical illustrations of some of the common methods of lining are given in the following cases:

The main ditch of the El Dorado Water and Deep Gravel Mining Company, El Dorado county, California, which is 40 miles long, with 70 miles of tributaries, is lined for a distance of between 2 and 3 miles with granite and slate rock. This is a very important ditch, having a capacity of 10,000 inches of water and actually delivering 4,000 inches, the loss by leakage being from 15 to 20 per cent. of the amount of water taken into the ditch. The grade is very low, only 4 feet to the mile. Notwithstanding the careful construction, repairs and cleaning cost about $900 per month.

The Park canal, in the same county, another important ditch, is lined in places with timber. The grade reported, 3 inches in 16 feet or 22½ feet per mile, is evidently an error, as the velocity of the water is given at only 3 miles per hour. The ditches belonging to this system are well puddled, and it is said that the leakage amounts to only 5 per cent. (2,200 inches, delivered). The cost of repairs, including flume-mending and cleaning of ditches, reaches $2,000 per year.

The Ridgeville ditch, in Minersville district, Trinity county, California, is cribbed with split rails placed close together and held in place by stakes driven in behind them. This ditch has a very steep grade, and for the first mile of the upper portion, where the pitch is 1½ inches to the rod (40 feet per mile), is walled with rock on the outside; the remainder of the line, 10½ miles, has a grade of 1 inch to the rod (26½ feet per mile). The necessity for thorough construction is evident when the force of the current, stated at 6 to 7 miles per hour, and possibly 8 miles in places, is considered. The cost of repairs is nominal.

The Trinity Hydraulic Mining Company's ditch, Taylor's Flat district, in the same county, is lined with 1½-inch lumber, 15 inches wide. The grade is only three-eighths of an inch to the rod (10 feet per mile), but the velocity of the current is reported at 4 miles in 55 minutes, or 4.367 miles per hour. This is a new ditch.

The Stevens & Leiter ditch, of the Oro Mining, Ditch, and Flume Company, California district, Lake county, Colorado, is lined with sod for a distance of 5 miles of its total length of 13½ miles. This ditch delivers 4,000 inches of water, and loses 10 per cent. by leakage. Its grade is low, 5 feet per mile, but the velocity of the water is stated at 3 miles per hour. Repairs are unimportant in amount.

The Black Hills Canal and Water Company's ditches, Whitewood district, Lawrence county, Dakota, supplying water to the mills at Central City, Deadwood, and Lead City, are, with the exception of one ditch (the Pioneer), underground boxed lines, the boxes made of pine lumber and covered over with 3 feet of earth, to prevent freezing in winter and evaporation in summer. The loss by leakage is 10 inches, against 181 inches delivered per hour. During two years run, up to the date of report, no repairs were required. In these ditches the fall is from ¼ to 1 inch in 16 feet (13½ to 27½ feet per mile).

From Georgia one report of partially lined ditches was received, the Anicaiola and Etowah line, in Dawson county. Here the system is to drive in planks at exposed points at the head of ravines.

One of the four ditches of Stevenson & Noble, in Pioneer district, Boisé county, Idaho, is cribbed with timbers and boards on the lower side. This ditch is a large one, has a grade of 1 inch to the rod (26½ feet per mile), giving a mean velocity of 4 miles per hour, and loses little by leakage. Repairs average only $400 per season.

The Rock Creek ditch, in Squaw Creek district, Deer Lodge county, Montana, is lined with granite for about a mile at its upper end. This is a large ditch, carrying 1,500 inches of water, with a low grade, 10 feet per mile.

The Diamond Flume and Hydraulic Company's ditch, German district, Meagher county, Montana, is walled in places where required with stone. It carries 2,500 inches of water, losing about 10 per cent. by leakage. The grade is half an inch to the rod (13½ feet per mile).

The Squaw Lake ditch, Applegate district, Jackson county, Oregon, is another example of partial lining. For short distances, where there is danger of breaking, it is faced with sawed lumber and slabs. The loss by leakage is 50 inches, against 1,000 inches of water delivered. The current is slow, 2½ miles per hour, with a fall of half an inch per rod. Repairs cost $1,200 during the second season, but the necessity for them diminished as the lining was improved.

FLUMES.—These are used for conveying water across cañons and in places where the grade of the line cannot be maintained by simple earth excavation, to avoid the necessity of cutting the ditch in hard rock, and in spots subject to washouts. They are not so permanent as well-constructed ditches, as they require constant repairs and are liable to damage or destruction by fire. Undoubtedly a substantially-built wall ditch in some instances would in the long run prove more economical than the side-hill fluming commonly adopted, though the first cost of the fluming might be much lighter. On the other hand, it is a question whether the wrought-iron siphon pipe is not preferable in many cases when excessively high trestle-work is required by flumes. But there are many cases where fluming is from topographical reasons unavoidable, and still more where the constructing engineer, after duly weighing the circumstances, finds it more expedient to adopt the simple flume than to attempt a more expensive system. Usually the consideration of first cost is a very weighty one. Large corporations, in building lines intended to be used for many years, can often afford very expensive construction for the sake of permanence. The small mine owner, however, is limited in his plans by the question of initial cost, and hence resorts to fluming wherever that is the simpler and cheaper way out of a difficulty. Flumes cost more per yard than excavation in easy ground where a natural grade exists, but much less than ditches hewn out of solid rock or flanked by high walls. Hence they are ordinarily used wherever their cost is less than that of other means, and this happens in many situations.

There are two leading types of flumes—those which are supported wholly by trestles, and those which follow the hill-side and are braced by struts. These two forms frequently appear in the same line of fluming, the natural bed being followed so far as practicable and then resort being had to trestles to bridge over the awkward spots. When the flume rests wholly or in part upon the earth or rock, it is advisable to set it in very close under the shelter of the bank, for protection against slides, and exposed points are either guarded by wooden aprons placed over the flume or by excavating the gullies beneath the flume. The construction of the flume itself and its framing is similar in either case, the differences in details of the trestle-work varying according to circumstances. For trestled flumes the features of the leading members are as follows:

Sleepers.—These are hewn timbers, preferably of red fir, but usually of whatever wood is at hand, resting upon the earth at right angles to the line of the flume, upon which trestle legs are set. Charring is sometimes resorted to as a protection against decay. They are from 6 by 4 to 10 by 6 inches and upward, and are placed flatwise. The object is not only to give a solid foundation for the trestles, but also to keep the latter from spreading; and for this purpose they should be slightly mortised, to hold the feet of the trestles in place. The length of the sleepers varies with the height of the trestle, the span increasing with the elevation of the flume above the ground. They are set at intervals of 8, 12, 16, and, rarely, 18 feet apart, according to the capacity of the flume and the weight of the superstructure, the former distance being usual with large and well-built flumes. The intervals between the supports are in multiples of 4 feet, which is usually the common distance between the posts of the flume-box, though occasionally the framing of the latter is set as close as 3 or even 2½ feet.

Trestles.—These are commonly two-legged, and for light flumes are made of 6-by-4 inch scantling, and sometimes of unhewn timber. For large flumes the size is increased to 10 by 8 inches and over. Low flumes, under 20 feet in height, of small to medium size, are made with alternate vertical single-leg supports, which support the weight, but have less resistance to the lateral movement of the structure. Very low flumes of from 3 to 6 feet in height may be carried by single legs alone when braced by struts. If sleepers are not used, it is advisable to char the feet of the trestles.

Cross braces of trestles are usually of refuse boards or planks, the same as employed for the sides and bottom of the flume-box, simply nailed to the trestle legs in the form of the letter X and terminating at the angle formed by the junction of the legs with the trestle-cap. Where single posts are used similar cross-braces are added, running from the sleeper to the trestle-cap and nailed to the post at their crossing, or diagonal scantling braces beginning at the post about midway from the ground and meeting the trestle-cap.

Diagonal struts.—These resist any longitudinal movement of the flume in mass, and are necessary with high flumes, especially if the gradient exceeds ½ inch to the rod, as is becoming more and more the practice. They are of 3 by 4 to 4 by 6 inch scantling, set edge up, and running alternately from trestle to trestle in the line of the flume.

Wire stays.—Very high flumes are much exposed to damage by storms and in curves by the momentum of the water carried. In such cases resort is had to wire guys securely anchored at the ground on both sides of the flume and attached at an angle of about 45°.

Trestle-caps, or bearers.—These rest upon the trestle legs at right angles to the line of the flume, and are never omitted. They are of 4 by 6, 6 by 6, or 8 by 8 inch hewn or sawed timbers. The trestle legs are sometimes mortised into the bottom of the cap. In the case of very high flumes, which often greatly exceed 100 feet, the cap becomes a sleeper for the trestle of the next story above, and so on. The lower stories of such flumes are, of course, of wider span than the upper ones.

Stringers.—These are longitudinal timbers, 6 by 4, 8 by 6, or 10 by 8 inches, set on edge, and of such length, usually 16 feet, as to bring the butts over the trestle-caps. They are placed beneath the sills under the posts of the flume-box, or a little outside of them. They give stiffness to the box, and are essential with flumes supported on trestles. Where the flume rests directly upon a rock bed they are sometimes omitted, but this is not considered good practice.

Sills.—These are timbers resting upon the stringers and parallel with the trestle-caps, 4 by 4 or 6 by 4 inches, and extending 18 or 20 inches beyond the posts on each side, where side-braces or knees are used, and 6 to 8 inches if there are no side-braces. The sills have shallow mortises for the reception of the posts, but are seldom mortised for the side-braces.

Posts.—These are from 2 by 4 with the smallest flumes up to 5- by 4-inch uprights with the largest ones. They are mortised into the sills, and usually also into the caps. The posts project about 2 inches above the sides of the flume.

Side-braces, or knees.—These take the lateral thrust of the box, and are 2- by 4-inch pieces, flat side up, extending from near the ends of the sills to the sides of the flume-box at about 45°. They are commonly simply nailed in place, and are not mortised to the sills. Some flumes have side-braces for each post—that is, at intervals of 4 feet; others have side-braces only at alternate posts, or at every third, fourth, or fifth post. Triangular blocks nailed to sills and posts are sometimes substituted, allowing the use of much shorter sills. Objection has been raised to the employment of side-braces at all, and the consequent extension of the sills, on the ground that additional space for the accumulation of snow and ice is thus made. If they are omitted, then the posts should be securely mortised into the caps, and the latter should be of considerable strength.

Caps.—When side-braces are used, the caps are sometimes simply nailed to the tops of the posts, and with very small flumes caps are occasionally omitted altogether. Their width is that of the posts, and the thickness ranges from 1½ to 5 inches, according to the mode of fastening. If mortised, the caps project from 6 to 10 inches beyond the posts. In some situations the absence of caps is a temptation to use the flume as a foot-bridge during the dry season, thus damaging the bottom boards, while, on the other hand, if the caps are to be walked upon it is evident that they should be sufficiently stiff.

The box.—The sides abut upon the posts and the bottom rests upon the sills of the framing, which supports the flumes at intervals of 4 feet. In California planks of heart sugar-pine are commonly used, but other woods are employed as circumstances dictate. The thickness is from 1½ to 2 inches, and with very small flumes sometimes only 1 inch. The length is 16 feet. With flumes of moderate capacity, if it is possible to get boards of sufficient width, say 20 inches and upward, it is an advantage to have the sides of single boards. This is impossible with the largest flumes, where two, and even three, boards are placed one above the other. The planking makes butt joints at the ends, the shrinkage of the wood in this direction being slight. Battens from 3 to 4 inches wide and the thickness of the planking or less, nailed upon the inside of the box, cover the longitudinal seams, except the corner joints, where the sides meet the bottoms. Only the very smallest flumes can be made with single bottom-boards. Knot-holes and large cracks are covered by short battens. When flumes are in constant use the leakage is very slight, and after disuse during the dry season the wood soon swells when the water is turned in and the flume becomes water-tight. Even with imperfectly-seasoned and rough-fitting lumber fluming, unless badly out of repair, carries the water with but little loss.

GRADE OF FLUMES.—The grade is either the same as that of the ditch portion of the same line or is heavier. The tendency of recent practice is to increase it, thus admitting of fluming with considerably less area than the corresponding cross-section of the ditches. From 25 to 30 feet is considered a good grade, and when there is sufficient head at the delivery end of the line some authorities recommend slightly heavier grades. The velocity of the water in flumes is higher than in ditches, especially where the fluming is perfectly straight. Velocities of 4 and 5 miles per hour are not uncommon, and in one case a speed of 7½ miles is credibly reported.

DIMENSIONS.—The size of flumes differs widely according to the amount of water carried and the grade. In the following specimen list the range is from 2 feet by 1 foot up to 8 by 6 feet, with much variation in the shape of the cross-sections. Usually the width is greater than the depth of water, often much more; but some flumes have a cross-section which is square, or nearly so.

TABLE XCII.—GRADE AND DIMENSIONS OF SPECIMEN FLUMES.

County and district.	Line.	Grade.	Width.	Depth.
ALABAMA.				
CLAY.		*Feet per mile.*	*Feet.*	*Feet.*
	Idaho	12½	2	1
ARIZONA.				
APACHE.				
Greenlee Gold Mountain	Boston	12	5	2½
CALIFORNIA.				
BUTTE.				
Cherokee	Spring Valley	12	5	3½
Morris Ravine	Morris Ravine	9	5	3
Oroville	Feather River and Ophir	11	6	3
CALAVERAS.				
Mokelumne Hill	Cook & Clarke	12	3	1½
	Mokelumne and Campo Seco	12		
DEL NORTE.				
	Bunker Hill	12½	4	2
	China Creek No. 1	18½	2½	1½
	China Creek No. 2	18½	3	1½
	China Creek No. 3	18½	2	1½
	China Creek No. 4	18½	4	2
	China Creek No. 5	18½	5	2
	Del Norte		7	1½
	Happy Camp	12½ to 40		
	Muc-a-muc	12½	3½	1½
	Wingate No. 1	18½	2½	2
	Wingate No. 2	12½	3	3
	Wingate No. 3	18½	3	3
EL DORADO.				
Georgetown	California	8 to 16	1½ to 4½	1½ to 4½
	El Dorado		8	6
	Park Canal		6	2½
PLACER.				
Gold Run	Gold Run	12	4	3
Iowa Hill	Iowa Hill	10	7	4½
PLUMAS.				
Indian Valley	Round Valley	10	3½	1½
Seneca	Dutch Hill	40	6	4
	Plumas	20½	4	3

TABLE XCII.—GRADE AND DIMENSIONS OF SPECIMEN FLUMES—Continued.

CALIFORNIA—Continued.

County and district.	Line.	Grade.	Width.	Depth.
		Feet per mile.	*Feet.*	*Feet.*
SHASTA.				
Igo	Dry Creek	6		
SISKIYOU.				
Indian Creek	Bay City No. 1	12½	1½	1½
Do	Bay City No. 2	12½	2	1½
Do	Coyote Creek No. 1	12½	1½	1½
Do	Coyote Creek No. 2	12½	1½	1½
Do	Coyote Creek No. 3	12½	1½	1½
McAdams Creek	Hiyou Gulch	12½	3	2
Oro Fino	Altoona	16⅔	5	2
Do	Barker	6⅔	4	2
Do	Wright & Fletcher	12½	7	2½
Quartz Valley	Shackelford Creek	12½	6	2
TRINITY.				
Taylor's Flat	Trinity	12½		
	Trinity G. M. Co		4	3
TUOLUMNE.				
Columbia	Tuolumne	11 to 33	7½	4½
COLORADO.				
LAKE.				
California	Stevens & Leiter	5	10	3
ROUTT.				
Hahn's Peak	Elk River	10	4	3
SUMMIT.				
	Boston G. and S. M. Co	7	2½	2
	Gold Run	6⅔	5	1½
DAKOTA.				
CUSTER.				
Battle Creek	Battle Creek Gravel M. Co	6⅔		
LAWRENCE.				
Confederate	Stockade	3 7/10		
PENNINGTON.				
Rockerville	Black Hills Placer M. Co	6		
GEORGIA.				
DAWSON.				
Fourth, Fifth, and Thirteenth	Anicolola and Etowah	8	5	4
HALL.				
Twelfth	Glade	8½		
LUMPKIN.				
Twelfth	Dahlonega	4	2	1
Do	Singleton	8	3	1½
WHITE.				
Third	Nacoochee	5	5	3
Fourth	Town Creek	5	3	2
IDAHO.				
BOISÉ.				
Boston	Spencer	12½	2½	3
Moore's Creek	Alderson	12½	4	2½
Do	Christy	10	4	2½
Do	Crepisculia (feeders)	10	3	1½
Do	Crepisculia (main)	10	2½	3
Do	Cuddy	12½	3	2
Do	Dunn	12½	3	2½
Do	East Moore's Creek	10	4	2½
Do	Hanson (upper)	10	3	3½
Do	Hanson (lower)	10	4	2½
Do	Lambing	12½	4	3
Do	Mountain	10	3	2½
Do	Plowman	12½	3½	2½
Do	Thorn Creek	10 to 12½	4	2½
Do	Upper Alderson	12½	3	2½
Pioneer	Stevenson & Noble	12½ to 16⅔	4	2
Do	Wilson	10 to 12½	4	3

TABLE XCII.—GRADE AND DIMENSIONS OF SPECIMEN FLUMES—Continued.

MONTANA.

County and district.	Line.	Grade.	Width.	Depth.
		Feet per mile.	*Feet.*	*Feet.*
BEAVER HEAD.				
Bannock	Bannock D. and M. Co		3	1½
Do	White Bar	6½	3½	1½
DEER LODGE.				
Henderson Gulch	Smart's Creek	6½	6	2
Squaw Gulch	Rock Creek	10	7	3½
Summit Valley	John Noyes	13½		
LEWIS AND CLARKE.				
Last Chance	Wm. A. Cheesman			
MEAGHER.				
German	Diamond Flume and Hydraulic Co		5	3½
Thompson Gulch	Birch Creek	12½	1½	1½

OREGON.

BAKER.				
Blue Cañon	Littlefield & Duckworth	12½	2	2
Do	Marysville	13½	4	3½
Chicken Creek	J. N. Osborne & Co	6½	1½	1½
Clarksville	Placer G. M. Co. (Burnt River line)	6½	6	2½
Do	Placer G. M. Co. (Clark's creek)	20	4	3
Pocahontas	Baisly	20	3	2
Shasta	El Dorado	8 to 12		
Sumter	Young & Rimbol	8½	4	3
COOS.				
	Pioneer	7½	4	1½
DOUGLAS.				
Big Bend Cow Creek	J. G. Fuller	17½	1½	1½
Do	D. A. Leavens	13½	2½	2
Do	D. F. Salmon	10	3	2½
Cañonville	Catching Bros	13½	3	1
GRANT.				
Cañon City	Humboldt	20	3½	2
Granite	Klopp & Johnson	30	1½	1½
Marysville	Hillis	6½	4	2½
Do	Miner's	5½	2	1½
Do	Thompson's	45½	3	1½
JACKSON.				
Applegate	Grand Applegate	20	4	4
Do	Squaw Lake	16	4	3
Farris Gulch	Farris Gulch	10	4	2½
Forty-nine	Ashland	53½	3	1½
Sam's Valley	Hays & Magruder	6½	2	1½
Sterling	Sterling		4½	3
JOSEPHINE.				
Waldo	Deselles No. 1	6½	4	3
Do	Deselles No. 2	6½	3	3
Do	Waldo	6½	5	4
Yank	Blue Gravel	26½	3	2½
	Josephine	13½	4	3

BRACKET FLUMES.—As an example of the many expedients for overcoming engineering difficulties in flume construction, the bracket flume of the Miocene Mining Company's ditch, in Butte county, California, may be cited. To avoid the necessity of a trestle-work 186 feet high, in crossing a deep cañon between precipitous basalt cliffs, the line of fluming was carried to the head of the cañon, where the perpendicular wall is 350 feet high. For a distance of 486 feet around this wall the flume is supported upon iron brackets, at a height of 118 feet above the bed of the ravine and more than 200 feet below the crest of the wall. The brackets are 8 feet apart, and are capable of sustaining a weight of 14½ tons each. They are made of T-rails of 30-pound railroad iron bent into the form of an L, 2 feet of which were rounded off and let into ring-bolts clamped and soldered into holes drilled in the rock. The bed of the flume rests upon the horizontal portion of the brackets, and the outer ends of the latter project vertically upward. Suspension rods of ¾-inch round iron run from the ends of the uprights diagonally upward to the wall, where they are securely clamped and soldered into the rock. The flume is 4 feet wide, inside measurement, and 3 feet deep, with a capacity of 3,000 inches of water. The dangerous work of drilling the holes for the brackets and suspension rods was done by men swung by ropes from the top of the cliff.

UNDERGROUND FLUMES.—For supplying quartz-mills with water during the winter, in districts where the cold is so great that freezing would prevent a regular flow, underground flumes or covered ditches are resorted to. Underground flumes are, more properly speaking, simply ditches which are completely boxed with plank and covered over with earth. They are not built with the same nicety of construction as ordinary open-air flumes, the surrounding earth forming a natural bracing and also diminishing leakage. Ditches, the sides and bottoms of which are not lined, are sometimes similarly covered over with lagging, brush, etc., upon which earth is thrown.

This covering not only protects the water from freezing in winter, but also serves to check evaporation in summer. The main objections to the system are the difficulty of inspection and the liability of choking from the top dirt falling into the channel in the case of ditches merely lagged over. The Arrastra, Montana, Hearst, and Deadwood lines of the Black Hills Canal and Water Company, of Lawrence county, Dakota, are examples of the underground flume system. These boxed ditches are covered with 3 feet of dirt, and carry water throughout the year to the mills which they supply. In many other places the same plan has been adopted. Short lengths of underground flumes or box ditches, sometimes strengthened by rock, are also used to convey water under road-beds, etc.

FEED PIPES.—The feed pipes immediately supplying the nozzles of hydraulic mines suggested the adaptability of a similar means for conveying water across deep cañons and over elevations impracticable by fluming. The system has developed into one of great importance and diversity of application, and has resulted in bringing a water supply to placer ground in many cases unavailable by any other means. The material used, sheet iron, is particularly adapted to its purpose by its great tensile strength in comparison with its weight, which is so slight as to render its transportation feasible from the point of manufacture to the locality where used, even though these are widely separated.

A description of the usual methods of construction, quoted from a valuable paper read by Mr. Augustus J. Bowie, jr., before the American Institute of Mining Engineers, and in part applicable to the construction of the feed pipes at the hydraulic mines, is here appended:

The general sizes of the pipes used in the mines are 40, 30, 22, 15, and 11 inches in diameter, of riveted light sheet iron, No. 16, 14, or 12 iron, Birmingham gauge, made in lengths of about 20 feet, and put together in stove-pipe fashion, neither rivets nor wire being used to hold the joints in place. These pipes are light, and can be readily and cheaply moved; this in hydraulic mining is of great importance, as it is often requisite to change the position of the lines of pipes. Pipe put together in this rough manner will remain tight when subjected to even as great a pressure as 200 pounds to the square inch. Where the pressure requires it, lead joints are used. [Formed by filling the space between an iron sleeve and the pipe with melted lead. A flange is bolted to one length of the pipe on the inside for the other pipe to fit over, and preventing the lead from entering the pipe.] Though roughly constructed and of very light iron, this kind of pipe (connected more like stove-pipe than water-pipe) is found in practice to be most serviceable, and, from its form, floating particles of matter readily render it water-tight. Such a pipe, 12 inches in diameter, made of No. 18 iron, is riveted in the longitudinal seams every inch to inch and a quarter; while in the round seams the rivets, which are only one-eighth of an inch in diameter, may be as much as 3 inches apart, showing daylight between the iron; but after the water has run through the pipes a short time nearly all leaks stop. If necessary, however, two or three bags of sawdust put in the inlets, and a few shovelfuls of earth, will usually make everything tight.

This class of pipe is now being replaced by one of better make, in which the round seams are made with rivets three-fourths of an inch apart, and the longitudinal seams are double riveted, with rivets one inch apart in the row, and about one-half inch apart from one row to the other. If riveted with care, such pipes, after being dipped in an asphaltum bath, are excellent, and will last for many years. For this asphaltum bath the following preparation can be used:

	Per cent.
Crude asphaltum	28
Coal tar (free from oily substances)	72
Or,	
Refined asphaltum	16½
Coal tar (free from oily substances)	83½

When the mass has been boiled to a proper consistency, and by test the coating is found to be brittle, it at once indicates that the mixture has been boiled too hot, or that there was too much oil in the tar or asphaltum.

The thickness of the iron is usually proportionate to the head of water and the diameter of the pipe. Pipes made of the different sizes iron here mentioned will stand the following strain per sectional inch:

Number of iron.	Made to stand strain per sectional inch, pounds avoirdupois.
12	7,000 to 9,000
12 to 9	9,000 to 12,000
9 to $\frac{1}{8}$-inch	12,000 to 14,000
$\frac{1}{8}$-inch to $\frac{3}{16}$-inch	17,000 to 18,000

The head of the water in pounds avoirdupois, multiplied by the diameter of the pipe in inches and divided by the above co-efficients, gives twice the thickness of the iron to be used. Allowance must be made for the security required, that is, if the breakage of the pipe will cause much damage it is advisable to lower the margin for greater safety. The diameters of the rivets usually used are:

Number of iron	18	16	14, 12, 11	10, 9, 7	¼-inch.	$\frac{5}{16}$-inch.	⅜-inch.
Corresponding diameter of rivets	$\frac{3}{16}$-inch.	$\frac{3}{16}$-inch.	$\frac{1}{8}$-inch.	$\frac{1}{8}$-inch.	$\frac{1}{8}$-inch.	$\frac{1}{8}$-inch.	$\frac{1}{8}$-inch.

They are usually spaced to make the pipe tight, that is, closer than is necessary for the strength of the seam; but this, in turn, is governed by the pressure on the pipes.

The following table shows the details of construction for a 22-inch pipe:

Thickness of iron.	Diameter of rivets.	Length of rivets.	Pitch of circle seams.	Number of rivets in each circle seam.	Pitch of the rivets in the longitudinal seam or double row.	Width between centers of rivets in the double row.
No. 12	$\frac{7}{16}$-inch	$\frac{3}{4}$-inch	1-inch	69	1$\frac{1}{8}$-inch	$\frac{5}{8}$-inch.
No. 11	$\frac{7}{16}$-inch	$\frac{3}{4}$-inch	1-inch	69	1$\frac{1}{8}$-inch	$\frac{5}{8}$-inch.
No. 9	$\frac{1}{2}$-inch	1$\frac{1}{8}$-inch	1$\frac{1}{16}$-inch	59	1$\frac{7}{16}$-inch full	$\frac{5}{8}$-inch.
$\frac{7}{16}$-inch	$\frac{1}{2}$-inch	1$\frac{1}{8}$-inch	1$\frac{7}{16}$-inch	39	1$\frac{11}{16}$-inch full	1$\frac{1}{16}$-inch.
$\frac{1}{2}$-inch	$\frac{1}{2}$-inch	1$\frac{1}{8}$-inch	1$\frac{7}{16}$-inch	39	1$\frac{11}{16}$-inch full	1$\frac{1}{16}$-inch.

When the pipe is made and put in position, air-valves are provided to allow the escape of air from the pipe while filling, and especially to prevent any collapse should a break occur. These valves are of many forms, the most usual being a piece of leather loaded and forming a valve opening to the inside of the pipe, and when shut covering a plain hole of from 1 inch to 4 inches on the top side of the valve. When required, a better class of valve is used, which sinks and opens when the water leaves it, and floats and shuts when the water rises up to it. An important point is the admission of the water to the pipe in such a way as to prevent air from being sucked into and traveling along the pipe, which will happen, and in large quantities, unless the water is regulated. The best plan is to put a gate in the pipe a little below the level where the water enters it, and regulate the flow by the gate, and by this means a steady pressure without violent oscillation can be obtained. Usually, however, the water enters through a funnel-shaped pipe, which allows the air to escape as it enters, and with a little care can be made to answer every purpose. In some instances an air- or stand-pipe is put in at a distance from the inlet. This catches the air as it travels along the top of the pipe and allows it to escape.

The following abstracts from the experts' reports give details as to the construction and duty of the pipes in different localities and under varying circumstances, showing the range in size and in pressure sustained in the typical cases:

ARIZONA.

YAVAPAI COUNTY.

JACKSON.—Diameter for 200 yards, 1 foot; for 175 yards, 7 inches; balance, 7 inches. Longitudinal joints are lapped and riveted; circular joints are lapped 2 inches and are held together by wiring four ears on each joint. These ears are riveted to the pipe.

CALIFORNIA.

BUTTE COUNTY.

CHEROKEE DISTRICT: *Spring Valley.*—Diameter, 30 and 34 inches. The iron used was ordinary English plate of fair quality. The greatest pressure it sustains is 887 feet, and the thickness of the iron at that point is $\frac{3}{8}$ of an inch. The pressure and maximum strains on the several sizes of iron used are given in the following table:

TABLE XCIII.—DETAILS OF THE SPRING VALLEY PIPES.

SIZE OF IRON.		GREATEST PRESSURE.		Maximum tensile strain per square inch, in pounds.
No. of gauge (Birmingham gauge.)	Thickness in decimals of an inch.	Feet.	Pounds.	
14	0.083	170	74	13,374
12	0.109	288	125	17,202
11	0.012	293	127	15,873
10	0.134	355	154	17,240
$\frac{3}{16}$	0.187	435	188	15,080
$\frac{1}{4}$	0.250	594	257	15,420
$\frac{5}{16}$	0.312	842	365	17,549
$\frac{3}{8}$	0.375	887	384	15,360

Longitudinal joints double-riveted; circular joints double-riveted and caulked. Longitudinal seams double-riveted; circular seams single-riveted. Air-valves are placed at several points.

MORRIS RAVINE DISTRICT: *Morris Ravine.*—Diameter of pipes, 22 inches; Nos. 12, 14, and 16 iron, used at depths of 250–310, 150–250, and 150 feet, respectively. Air valves placed where the pipe changes its angle. Joints single-riveted, and tarred before joining.

CALAVERAS COUNTY.

MOKELUMNE HILL DISTRICT: *Cook & Clarke.*—Diameter, 12 inches; thickness under greatest head, No. 14 Birmingham gauge. All joints riveted. One air-valve near head.

Mokelumne and Campo Seco.—Diameter, 12 to 14 inches; Nos. 16 and 14 Birmingham gauge. Sections (18 or 20 feet) stove-piped and riveted. Depth, 70 feet.

EL DORADO COUNTY.

GEORGETOWN DISTRICT: *California.*—Diameter, 7½ to 22 inches; Nos. 12, 16, 18, and 20 iron. Longitudinal slip-joints stove-piped and riveted, circular joints riveted. No air-valves. Depth of cañons crossed, 40 to 200 feet.

El Dorado.—Diameter, 16 to 30 inches; Nos. 18 to 12 Birmingham gauge. Made in 20-foot sections. Slip-joints and riveted. Air-valves every hundred feet.

Park Canal.—Diameter, 15 to 22 inches; Nos. 18 to 14 Birmingham gauge. Longitudinal joints stove-piped and wired or double riveted, circular joints riveted. Air-valves at highest points. Depth, 128 feet.

PLACER COUNTY.

GOLD RUN DISTRICT: *Gold Run.*—Diameter, 16 inches; No. 14 Birmingham gauge throughout. Joints stove-piped and riveted. Air-valves 150 feet apart throughout length of pipes.

PLUMAS COUNTY.

SENECA DISTRICT: *Dutch Hill.*—Diameter, 22 inches. The iron varies between single riveted No. 14 to doubled riveted No. 12—the latter used at point of greatest pressure, 518 feet, 5 miles from the head of the pipe. Longitudinal joints single or double riveted, according to pressure; circular joints are driven together and fastened by means of hooks. Air-valves are placed at the highest points along the line.

TUOLUMNE COUNTY.

COLUMBIA DISTRICT: *Tuolumne.*—Diameter, 6 to 16 inches, averaging 11 inches. Average thickness, No. 16 Birmingham gauge, 0.065 inch shell, weighing 2.627 pounds per square foot. Joints riveted. Air-valves at head.

COLORADO.

LAKE COUNTY.

CALIFORNIA DISTRICT: *Stevens & Leiter.*—Diameter, 13, 15, 18, 21, and 30 inches; all No. 14 iron. No air-valves.

DAKOTA.

LAWRENCE COUNTY.

WHITEWOOD DISTRICT: *Black Hills Canal and Water Company.*—Diameter, 8 inches; No. 14 iron. Lap-joints held by four lugs drawn together by wire. Depth of cañon crossed, 250 feet.

GEORGIA.

LUMPKIN COUNTY.

TWELFTH DISTRICT: *Dahlonega.*—Diameter, 12 inches; No. 16 iron. Spiral pipes, single riveted. Circular sleeve-joints, ends fluted and joined by wired lugs. No air-valves.

Hand.—Diameter, 36 inches. Thickness at greatest pressure, ⅜ inch; at other points, $\frac{3}{16}$. Grade between head and discharge, 8 feet to the mile. Longitudinal lapped-joints double riveted in one section, 42 feet in length, single riveted in the other sections. Circular flange-joints made of cast iron turned in lathe, made tight with lead, and bolted with ¾-inch bolts at intervals of 6 inches in the circumference. Joints riveted to the pipes. No air-valves, but the pipes are provided with man-holes.

WHITE COUNTY.

FOURTH DISTRICT: *Town Creek.*—Diameter of upper third, 20 inches; middle third, 18 inches; lower third, 16 inches; $\frac{3}{16}$-iron. Spiral pipe, single riveted. Circular sleeve-joints, one end corrugated, united by lugs and wire. Joints covered with rubber-cloth and three thicknesses of tarred canvas, with three iron clamps over each joint. Air-valves used.

IDAHO.

BOISÉ COUNTY.

MOORE'S CREEK DISTRICT: *Plowman.*—Diameter, 11 inches; No. 18 iron; pressure, 84 feet. Longitudinal slip-joints; circular joints made with an elbow in one piece. No air-valves.

MONTANA.

MEAGHER COUNTY.

GERMAN DISTRICT: *Diamond.*—Diameter, 22 inches; thickness, ¼-inch throughout; pressure, 440 feet; joints riveted. No air-valves.

OREGON.

GRANT COUNTY.

GRANITE DISTRICT: *Klopp & Johnson.*—Diameter, 18 inches; thickness, $\frac{1}{16}$ throughout. Longitudinal joints riveted; circular slip-joints. No air-valves. Greatest depth, 84 feet.

JACKSON COUNTY.

FARRIS GULCH DISTRICT: *Farris Gulch.*—Diameter, 22 inches; thickness, $\frac{1}{16}$ throughout; pressure, 60 feet. Longitudinal slip-joints; circular joints made with curved elbow, riveted. Three air-valves near head.

In addition to the pipes carrying water for the use of hydraulic mines, examples of bold engineering are shown by the lines of several water companies supplying cities on the Pacific coast. Among these the line of the Virginia City and Gold Hill Water Company is the most noteworthy. It includes an inverted wrought-iron

siphon, 11½ inches in diameter, which sustains a pressure of 1,720 feet or 750 pounds per square inch at its greatest depression. At this point No. 0 iron is used, hot-riveted with ⅝-inch rivets, double row on the longitudinal seam and single riveted on the round seam. It is said to have been tested to a pressure of 1,400 pounds per square inch. A second siphon, made of lap-welded pipe, ¼-inch iron, 10 inches inner diameter, has been added.

The pipe of the Spring Valley Water Company, which supplies San Francisco, is 18 inches in diameter and 5,800 feet long, and has a tensile strain of from 5,000 to 6,000 pounds per sectional inch. It is subjected to the pulsations of a single-acting plunger pump making at times 36 strokes per minute.

The Vulture Pipe Line, Maricopa county, Arizona, is included in the official schedules, though it is not used for hydraulic mining, but for supplying the Vulture 80-stamp mill. It is 16 miles long, and the diameter for the first 5½ miles is 9 inches; balance, 7½ inches. It is of No. 19 iron, in bands of 2½ feet, made into sections 24 feet long. The longitudinal joints are slip-joints riveted together; the circular joints are made by slipping 4 inches of the end of one section into the next without riveting, and are wrapped around with rags. There are no air-valves. For 5 miles the pipe falls 5 feet to the mile, and water is then raised 320 feet in a distance of 6,200 feet by steam pumps driven by a 50 horse-power compound engine; thence to point of delivery the grade is 11 feet per mile. The greatest pressure is stated at about 40 pounds per square inch.

RESERVOIRS.—For the purpose of storing water for use during the dry season many of the mining and water companies have constructed expensive dams, forming large reservoirs. These dams are built of logs, stone, or earth and brush, or a combination of these materials, and are commonly faced with water-tight planking. Culverts, gates, and strainers are provided for drawing off the water. In California there are many such fine examples of engineering skill, costing upward of $100,000 each, from 60 to 130 feet high, with catchment basins of from 5 to 30 square miles. Some idea of the magnitude of these dams and reservoirs may be gained from the following list (*a*) of the respective capacities of reservoirs on the Feather, Yuba, Bear, and American rivers, in California:

TABLE XCIV.—RESERVOIRS ON THE FEATHER, YUBA, BEAR, AND AMERICAN RIVERS IN CALIFORNIA.

Name.	Capacity in cubic feet.
Total storage	7,600,000,000
North Bloomfield	1,050,000,000
Milton	650,000,000
Eureka lake	1,130,000,000
South Yuba	1,800,000,000
Omega and Blue Point	300,000,000
Spring Valley	800,000,000
California	800,000,000
El Dorado	1,070,000,000
Other small reservoirs on the Feather, Yuba, and American rivers.	700,000,000

ACCIDENTS TO DITCH LINES.—Few lines escape without more or less small breakages or washouts during a season's run. At times, when the ditches are not in use, they are also liable to damage from storms, slides, and other causes; but it seldom happens with well-constructed lines that any serious injury is received sufficiently great to be termed an accident. Inquiries made as to the accidents which occurred during the year, their character, cause, and effect, developed the fact of their infrequency. The subjoined analysis of the answers received on this head shows that out of 175 lines examined, representing 3,049½ miles, only 24 reported accidents of any kind, however trivial, while 116 reported no accidents, and 35, in which there were also probably none, returned no account of any.

TABLE XCV.—ACCIDENTS TO DITCH LINES.

State or territory.	Number of ditch lines reported.	Number reporting accidents.	Number reporting no accidents.	Blanks, probably no accidents.
Total	175	24	116	35
Alabama	1	1	.....	.....
Arizona	3	.....	2	1
California	65	9	31	25
Colorado	8	1	6	1
Dakota	6	.....	5	1
Georgia	8	.....	7	1
Idaho	17	.....	17	.....
Montana	11	2	9	.....
Oregon	56	11	39	6

a From Lieutenant-Colonel Mendell's report, page 13, quoted on the authority of Mr. Hamilton Smith, jr.

Among the accidents reported the following cases serve to illustrate the more common causes of damage:

In Alabama the Idaho ditch, in Clay county, suffered from small caves and washouts, caused by the boring of cray-fish. The usual remedy for this annoyance consists in putting in fluming instead of reconstructing the ditch.

In California the Feather River and Ophir line, at Oroville, Butte county, reports injury from several slides on the hill-side, requiring a considerable force for repairs and entailing a delay of fourteen days. The Mokelumne and Campo Seco line, in Calaveras county, met with breaks caused by heavy storms and also by the burrowing of gophers. The superintendent states that gophers are the worst enemies of ditch-owners in this locality. In Del Norte county a slide in the ground carried away part of the Del Norte ditch, which had to be replaced by fluming; and a reservoir belonging to the Hungarian Hill Mining Company, in Plumas county, was swept away during the month of May, entailing a loss of $4,000 and much inconvenience. Heavy storms of rain and snow caused slides and breaks in the ditches of the Fort Goff line at Sciad Valley, Siskiyou county. The Buckeye ditch, in Trinity county, was also badly damaged by a slide during the winter, while the Lewiston ditch at Junction City, the Trinity at Taylor's Flat, and Chapman & Fisher's line, all in the same county, suffered more or less from slides.

The only accident reported from Colorado was the breaking of a short section of a flume in California gulch, Lake county, owing to the rottenness of the wood.

In Idaho the casualties were of too small importance to be classed as accidents.

The Bannock ditch, in Beaver Head county, Montana, had two considerable breaks, one caused by flood and the other by gradual undermining, necessitating repairs to the extent of $1,000. In the same county the White Bar flumes were broken by rock falling upon them from the cliffs.

In Oregon quite a number of minor accidents occurred. The line of J. N. Osborne & Co., in Chicken Creek district, Baker county, broke five times during the year, 60 feet of flume being carried away on each occasion; but the repairs were promptly made, and only a delay of ten days ensued. A slide injured the Nelson ditch, Pocahontas district, in the same county, but the damage was repaired by ten men in five days. In Shasta district, also in Baker county, five rods of the El Dorado ditch were washed away, and in Sumter district the Young & Rimbol line met with two slight accidents—one from a snow slide, caused by the rapid melting of the heavy snow, and one from the ditch overflowing. In Coos county the Pioneer ditch was damaged by the caving and breakage of the embankment and the flume fell in places. Part of the Thompson flume, in Marysville district, Grant county, was blown down during the winter, but it was repaired before the opening of the season. In Jackson county the Squaw Lake ditch, Applegate district, was filled by a heavy snow-storm in the beginning of January, which caused a suspension of mining for seventeen days and necessitated constant repairs to the ditch during that month and throughout February. The Sterling ditch, in Sterling district, was broken in three places, and was repaired by putting in flume boxes at the weakened spots without much delay. At Wolf Creek a slide of land and snow carried away a section of Gross Brothers' main ditch, and for two months the line was in an insecure condition. The Blue Gravel ditch, in Josephine county, reports a few small breaks, without serious effects.

The foregoing "chapter of accidents" covers the more frequent vicissitudes to which artificial water channels are subject. That the injuries are not of greater moment is owing to the constant inspection and prompt attention given to strengthening weak and threatened points. Some disasters, such as those caused by very heavy storms and unusual freshets, are inevitable even with the most painstaking supervision; but the surest guarantee of security is a strict observance of the time-honored maxim, especially applicable to ditch-tenders, that "a stitch in time saves nine". The first insidious attacks of flowing water are easily combated if detected at an early stage; it is only when they are allowed to pass unnoticed and unchecked that they become irresistible, as a spadeful of dirt at the right moment will often obviate the necessity for days of repairs.

REPAIRS.—The ordinary trifling damages are considered by owners as matters of course, and their repair is looked upon in the light of a regular and necessary item of expense, included under the general head of work preliminary to resuming operations at the beginning of each season. While such small breakages, as a rule, are individually slight, they amount in the aggregate to a large annual tax upon the water interests; and even with single lines their frequent recurrence entails large expense, while the general overhauling, cleaning, puddling, and strengthening of the longer ditches calls for a heavier outlay than does the average "accident", and sometimes reaches a high percentage on the original cost of construction. The repairs during the year on the Mokelumne and Campo Seco line, in Calaveras county, California, for instance, amounted to $6,000, as against a first cost of $50,000, or 12 per cent.; on the Round Valley, in Plumas county, they reached 6 per cent.; on the Plumas, in the same county, $10,000 on an investment of $50,600, or 20 per cent., including, however, a thorough regrading of the ditch; the Rock Creek line, in Deer Lodge county, Montana, $2,500 in repairs, against $20,000 first cost, or 12½ per cent.; and many others ranged from 3 to 15 per cent. Among lines calling for large expenses of this kind may be mentioned the Spring Valley, $5,000 per year; the Morris Ravine, $4,500; the Happy Camp, $1,000; the California, $2,500; the El Dorado, $9,600; the Park Canal, $2,000; the South Yuba, $15,000; the Gold Run, $2,000; the Iowa Hill, $3.000; and the Tuolumne, $8,000—all in California; the Elk River, in Colorado, $2,400; the East Moore's Creek, $1,000, and Plowman, $1,400, in Idaho; the Bannock, $1,000, in Montana; and the El Dorado, in Oregon, $6,240; the Osborne, Placer Gold, Borne & Lucas, Squaw Lake, Farris Gulch, and Sterling lines entailing an annual expense for repairs of $1,000 each or over.

The smaller, cheaper, and less permanent lines require lighter annual expenditure per mile for repairs than the plant of the greater engineering enterprises, but these repairs amount to a higher percentage upon first cost. The yearly improvements (other than repairs included under the head of general labor) upon 2,836½ miles of ditch amounted to $114,365 50, or $40 32 per mile. This corresponds to a yearly tax of 1.06 per cent. upon an original investment of $10,780,414 31. A similar rate of expense is assumed to have been incurred by 213 additional miles scheduled, bringing the total for 3,049½ miles up to $122,953 66. In the absence of data for estimating what proportion of the repairs incidental in operating 7,733½ miles of ditch included in the total plant are to be assumed as additional to the cost of regular attendance, or even what proportion were in active use, the arbitrary ratio of $10 per mile is assumed as being within the probabilities. As the lines not included in the schedules of the experts were, as a rule, of the less important class, it is not probable that their cost of maintenance would be so high as that of the scheduled lines. To recapitulate:

Annual cost of repairs on 2,836½ miles of ditch (as given by schedule returns)	$114,365 50
Estimated annual cost of repairs on 213 miles scheduled, but without specified cost	8,588 16
Estimated annual cost of repairs on 7,733½ miles not scheduled	77,335 00
Total	200,288 66

WAGES OF EMPLOYÉS.—The price paid for labor varies greatly in different localities. In Georgia, for instance, as low as 50 cents per day is reported, while in Dakota, Idaho, and Montana, where the cost of living is necessarily very high, the pay often reaches $4. California, which contains the largest artificial water system, shows a medium status in respect to wages, the rates paid being sufficient to maintain the employés comfortably and yet not severely taxing the ownership. Wages at $3 per day in the latter state admit of better living than would $4 in the territories. Chinese laborers receive much less than do the whites, usually from $1 30 to $2 per day; though in some cases as much as $3 per day is earned by skilled Chinese in Idaho. As a rule, their pay averages from one-half to two-thirds that of white men engaged in the same character of work. It is customary in some districts for the employés to mess together, receiving board in part payment. The following statements give the range of salaries and wages (without board) in different parts of the country:

ARIZONA.—Ditch tenders, $60 per month to $3 per day.

CALIFORNIA.—Superintendents, $100 to $250 per month; collectors, $75 per month; bookkeepers, $50 per month; ditch builders, $3 per day; ditch tenders, $1 50 to $3 per day; Chinese laborers, $1 30 per day.

COLORADO.—Ditch tenders, $2 50 to $3 per day.

DAKOTA.—Ditch tenders, $2 50 to $4 per day.

GEORGIA.—Ditch tenders, 50 cents to $1 50 per day.

IDAHO.—Ditch builders and tenders, $4 per day; Chinese ditch cleaners and laborers, $2 25 to $3 per day.

MONTANA.—Ditch tenders, $60 per month to $4 per day.

OREGON.—Ditch tenders, $40 per month to $3 per day.

The length of shift for ditch employés is from ten to twelve hours per day, more commonly the longer time, depending upon the number of hours run in the hydraulic mines supplied by the ditches. The average price per day for all employés, Chinese included, is $2 75, without board.

An examination of the reports from scattered districts shows an average of one person employed for every 10 miles of ditch; but this does not include the irregular attendance upon ditches by men engaged for the greater part of their time in hydraulic mining, and who are consequently classed with the regular mine force. The wages paid to the force employed for a short period at the beginning of the supply season in making repairs and overhauling the lines preparatory to active operations are also considered in the foregoing statement of cost of repairs. In the same way the men at work in constructing new lines are also excluded from the regular force of the ditches, as their wages appear under the heading of cost of plant. The wages of employés usually continue only during the water season, though a few of the more important lines, which do not furnish water during the whole year, keep a small force constantly occupied. The amount paid for attendance during the season of 1880 is estimated at $626,991 75, being the wages of 1,078 employés of all classes for 211½ days at an average pay of $2 75 per day.

DURATION OF DITCH LINES.—From reports on 142 ditch lines it is found that the average date of the original construction of the lines now in operation, so far as reported upon, was 1867, which may be taken as the time of greatest activity in ditch building. Many of these ditches, however, have been enlarged or improved since that time to such an extent as to amount to a virtual reconstruction. A few ditches in California and Oregon still in useful service date back to 1850. Of existing ditches in Montana the oldest were built in 1861, and in Idaho the oldest date from 1863; but the average life or period of useful duration from the time of first construction up to the close of the census year is thirteen years. For California, owing to the earlier inception of hydraulic mining, the average is still higher, or eighteen years.

SALE OF WATER.—Of the ditch lines reported upon, 72 per cent. supply water only to mining ground held under the same ownership as the water rights, and do not sell water, either the whole or in part. Some of the more important lines are owned by water companies which do not themselves use the water for mining or other purposes, but derive their revenue solely from the sale of water to hydraulic mines, quartz-mills, etc., or for irrigation and domestic use. A larger number of water owners, however, sell only such quantity as is a surplus above

what is required for supplying their own mines, this surplus being either a constant amount beyond their own requirements, or the balance of water running in the ditches toward the close of the season, at times when the supply is too low to be available for working their own claims. The amount required varies greatly with the "rig" of different mines, it being possible to work some claims with much less water than is demanded by others, and also to continue ground-sluicing after the supply is too light for hydraulicking. Very frequently, too, a head of water, having become insufficient for operating the higher hydraulic mines, is still useful on lower ground, where the fall partly offsets the deficiency in quantity. The proportionate extent to which the ditch lines (including water rights) and the mining property are held under the same ownership is illustrated in the following analysis. Possibly with fuller returns this proportion (72 per cent.) of unity of ownership would be still higher, as the reports are mainly of the larger ditch lines—that is, those which are more apt to be sellers:

TABLE XCVI.—SALE OF WATER.

State or territory.	Number of ditch lines reported.	Number of lines which sell water in part or wholly.	Number of lines which supply only owners' mines.
Total	143	40	103
Alabama	1	.....	1
Arizona	2	.....	2
California	40	14	26
Colorado	6	.....	6
Dakota	6	1	5
Georgia	8	3	5
Idaho	17	10	7
Montana	11	3	8
Oregon	52	9	43

In California the rates charged for water vary greatly, the lowest price reported being 3 cents per inch for twenty-four hours, in Butte county. In the same county, however, another line charges 5 cents per inch for ten hours. Other rates are 5, 7, 10, and 12 cents per inch for twenty-four hours, the highest price reported for that length of time for water used in hydraulic mining being 25 cents per inch. One company in Calaveras county charges 10 cents per 24-hour inch for first water, but less for water which is used over again. One mine in Del Norte county sells its surplus of water to small claims at $50 each per season, and after closing down its own works sells the whole of the water running during the balance of the season. A large water company in El Dorado county has the following scale of prices: To hydraulic mines, 6½ to 10 cents per 10-hour inch, according to quantity purchased; to quartz-mills, 20 cents per 24-hour inch; for irrigation, 25 cents per 24-hour inch. Another large company in Tuolumne county, which supplies water also for two flour-mills, one foundery, and other power, as well as for irrigation, etc., reports the following price-list for water used in hydraulic mining:

One stream of 12 inches	per day..	$3 00
One stream of 15 inches	do....	3 50
One stream of 18 inches	do....	4 00
One stream of 21 inches	do....	4 50
One stream of 24 inches	do....	5 00
For larger amounts up to 48 inches	per inch..	20
From 60 to 100 inches	do....	18

A company in Shasta county which receives 5 cents per 10-hour inch asks 10 cents for 24-hour inch. These last rates may be taken as the average throughout the state for localities well supplied with water and during favorable seasons.

The quartz-mills in Whitewood district (Black hills), Dakota, pay for water-power at the low rate of $2 a week per stamp.

In Georgia the rates reported are 12 and 12½ cents per inch.

The prices paid in Boisé basin, Idaho, are 10, 12½, 13, 15, and, in one case (a small head of 100 inches), 30 cents per 24-hour inch. Rates in this locality vary according to the quantity sold, and also according to the elevation of the delivery point above the claims supplied. Thus, of two parallel ditch lines, one, the lower, sells water at 10 cents per inch, while water from the higher line commands 15 cents. One firm owning a large area of placer ground which is controlled by their own water rights makes a practice of leasing claims to Chinese miners free of charge for the profit in selling water to them. It may here be remarked that in some districts it is not unusual for the Chinese to be taxed a considerably higher water rate than is charged to white miners.

The rates reported in Montana are 10 cents per 10-hour inch, 16 cents per 20-hour inch, and 15 cents per 24-hour inch.

In western Oregon the conditions are similar to those in California, the price of water quoted in the schedules being, if anything, slightly lower than in the latter state. Rates reported in Baker county, in the eastern part of the state, are 8, 10, 12½, and 15 cents per 10-hour inch, and in one case as low as 7½ cents per 24-hour inch. The lowest price stated for this county is one lease of 275 inches (full time) for $30 per week, or only 1½ cents per inch daily—possibly an error. One ditch-owner here has adopted a sliding scale of prices regulated by the relative mining profits of his customers, charging more for water supplied to the best producing claims than to those which do not pay so well. The report does not state whether this discrimination is for the purpose of encouraging the mining industry, or whether, as in other matters, the price is determined by what the buyer can afford to pay. In Grant county a somewhat similar discrimination is noted, 50 cents per inch of twelve hours being charged for water used in washing drift dirt, as against 6 cents per inch for the same time for hydraulic mining, though in this case the element of relative quantity is perhaps the deciding consideration.

It may be laid down as a general rule that the price of water depends not so much upon its scarcity or abundance, or upon the expense of conveying it, as upon the status of the mining interest in any given locality. Thus, when a new placer camp is first opened and the miners are making large profits by working only the richer spots, they are willing and able to pay the owners of water rights rates which, in the subsequent seasons, when the best ground has been exhausted, would be prohibitory. In working large masses of gravel, containing only a few cents per cubic yard, the closest economy is necessary to a profitable result; and if the miner finds that with a certain water tax his net outcome is not satisfactory, then the water-owner, perforce, has to reduce his charge or let his ditches lie idle. This fact establishes a natural equilibrium.

Competition does not affect prices to the extent which might be supposed. In a large number of cases, for a given gravel deposit there is practically only one available source of supply, owing to the manner in which water rights are secured. Where there is competition, the higher head of water, other things being equal, commands the better terms.

THE MINER'S INCH.—The miner's inch is a simple and convenient measure of water, an early outgrowth of hydraulic mining, and is the recognized unit upon which prices are fixed and estimates of efficiency based. It is, however, an entirely arbitrary standard, varying considerably in different districts according to the local definition prevailing, and is occasionally of irregular value even in the same district. This variation is practically not a matter of very great consequence, as the range in price is far wider than that of measure; but, for the purpose of comparison, it would undoubtedly be an advantage if a uniform standard and an identical mode of applying the measurement were adopted throughout the country.

The conditions which affect the value of the inch are the head (measured in some cases from the top and sometimes from the center of the orifice); the form of the aperture, its height, and in a less degree the distance between its lowest point and the bottom of the measuring box; the thickness of the plank or partition through which the water flows; and the nature of the approaches, and the character of the fall on the delivery side of the aperture. As these conditions are varied in different localities, the amount of water delivered varies correspondingly. The following deductions (*a*) from experiments on the discharge of fluids from reservoirs are here applicable:

1. That the quantities of a fluid discharged in equal times by the same apertures from the same head are nearly as the areas of the apertures.

2. That the quantities of a fluid discharged in equal times by the same apertures, under different heads, are nearly as the square roots of the corresponding heights of the fluid above the surface of the apertures.

3. That the quantities of a fluid discharged during the same time by different apertures, under different heights of the fluid, are to one another in the compound ratio of the areas of the apertures and of the square roots of the heights of the fluid above the center of the aperture.

4. That, on account of the friction, small-lipped or thin orifices discharge porportionally more fluid than those which are larger and of similar figure under the same height of fluid.

The most common definition of the miner's inch is "the amount of water discharged through an opening 1 inch square under a pressure of 6 inches above the opening". This is qualified in some districts by limitation as to the thickness of the partition, which is usually a 2-inch plank. The standard of pressure is irregular, being sometimes more and sometimes considerably less than 6 inches, but the ordinary range is from 4 to 6 inches. The abstract definition and the mode of applying the measurement do not, however, always coincide. In practice, for the sake of convenience in measuring large quantities, a higher aperture than that of 1 inch is often used, in order to dispense with very wide gauge-boxes. Thus, an opening 2 inches high delivers 2 "miner's inches" per inch in width of the box; that is, if the aperture extends across 20 inches, it will deliver 40 miner' inches. The opening is sometimes made still higher; if 3 inches, then each inch in width delivers 3 miner's inches, and if an aperture of this height is 20 inches wide it will deliver 60 miner's inches. Table XCVII shows the varieties in definition and in application as given by schedule answers from 146 hydraulic mines in different localities.

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a *Engineers' and Mechanics' Pocket-Book*, Charles H. Haswell, 1879, p. 359.

TABLE XCVII.—VARIOUS DEFINITIONS OF THE MINER'S INCH, AS REPORTED IN SCHEDULES.

Definition locally accepted.	Total number of replies, according to nature of definition.	Arizona.	California.	Colorado.	Dakota.	Georgia.	Idaho.	Montana.	North Carolina.	Oregon.	South Carolina.	Utah.
Total number of replies, by states and territories	146	2	45	10	11	9	8	13	1	50	1	1
Stream of water passing through—												
"A square inch orifice under 6-inch head" (thickness of partition and point from which pressure is measured, whether top, center, or bottom of orifice, not stated).	97	1	20	10	11	5	1	11	.....	38	.....	.....
"A square inch orifice under 6-inch head above top" (thickness of partition not stated)	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
"A square inch orifice under 6-inch head, measured from center; 2-inch plank"	3	.....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....
"A square inch orifice under 6-inch head" (point from which pressure is measured not stated); "2-inch plank".	7	.....	7	.....	.....	.....	.....	.....	.....	.....	.....	.....
"A square inch orifice under a head varying from 4 to 6 inches"	2	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
"A 1-inch orifice under 4-inch head"	5	.....	3	.....	.....	4	.....	.....	.....	.....	.....	.....
"An orifice 2 inches high under 5-inch head" (delivering 2 miner's inches per inch in width of orifice).	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
"An orifice 2 inches square under 6-inch head from center" (= 4 miner's inches).	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
"An orifice 3 inches high under 3-inch head" (delivering 3 miner's inches per inch in width).	9	.....	.....	.....	.....	.....	.....	.....	.....	9	.....	.....
"An orifice 3 inches high under 6-inch head" (delivering 3 miner's inches per inch in width).	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
"An orifice 4 inches high under 4-inch head" (delivering 4 miner's inches per inch in width).	2	.....	1	.....	.....	.....	.....	.....	.....	1	.....	.....
"An orifice 4 inches high under 6-inch head, above top of aperture" (delivering 4 miner's inches per inch in width).	1	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
"An orifice 6 inches high under 3-inch head above top, shingle partition" (delivering 6 miner's inches per inch in width).	1	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
A delivery of—												
"10 gallons per minute"	2	.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....
"675 gallons per hour"	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
"1.5 cubic feet per minute"	1	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....
"10 gallons per minute; or, water flowing through an orifice 1 inch square in a thin vertical partition, under 5-inch head."	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Running inch: in cross-section of ditch or flume, without pressure	8	.....	8	.....	.....	.....	.....	.....	.....	.....	.....	.....

The average delivery of the common miner's inch, as determined by Mr. J. D. Hague, is 1.5625 cubic feet per minute, 93.75 cubic feet per hour, and 2,250 cubic feet per twenty-four hours.

Very careful experiments were made in 1874 by Mr. Hamilton Smith, jr.,(a) at Columbia Hill, California, latitude 39° north, elevation 2,900 feet above sea-level. The module used was a rectangular slit 50 inches wide and 2 inches high, pressure 7 inches above the center of the opening. The discharge was over a 3-inch plank, the last inch chamfered. The size of the opening was taken with a measure (micrometer attached) which had been compared with and adjusted to a standard United States yard. Time was read to one-fifth of a second. The level of the water (drawn from a large reservoir) was determined with Boyden's hooks, micrometer adjustment. The following results were obtained:

	Cubic feet.
One miner's inch will discharge in one second	0.02624
One miner's inch will discharge in one minute	1.5744
One miner's inch will discharge in one hour	94.4640
One miner's inch will discharge in twenty-four hours	2,267.1360

Ratio of actual to theoretical discharge, 61.6 per cent. These figures are stated to be within the limit of 1–500 possible error.

In 1878 a further series of experiments to determine the effective value of the above described inch (which is that used at the North Bloomfield, Milton, and La Grange mines), made at La Grange by Mr. Aug. J. Bowie, jr., gave the following results:

	Cubic feet.
One miner's inch discharged in one second	0.02499
One miner's inch discharged in one minute	1.4994
One miner's inch discharged in one hour	89.9640
One miner's inch discharged in twenty-four hours	2,159.1360

Ratio of effective to theoretical discharge, 59.05 per cent.

At Smartsville, Yuba county, California, the water is measured by a 4-inch orifice with a 7-inch board top, or a pressure of 9 inches above the center of the aperture, each inch in width giving 4 miner's inches. The bottom of the aperture is flush with the bottom of the box, and the board top is 1 inch thick. Mr. Thurston's determination of the value of this unusually large miner's inch is 1.76 cubic feet per minute, 105.6 cubic feet per hour, and 2,534.4 cubic feet per twenty-four hours for each square inch of the opening.

For the purposes of this investigation the average delivery of the miner's inch is assumed to be 700 gallons per hour, which corresponds to 0.1944+ gallon per second, 11.666+ gallons per minute, and 16,800 gallons per twenty-four hours.

a *Transactions of the American Institute of Mining Engineers*, vol. vi, p. 59.

GAUGE-BOXES.—One of the simplest forms of the common instrument for measuring water is described in the report upon the placers of Boisé basin, Idaho. In this particular case the box, made of 1½-inch pine boards, is 48 inches wide, inside measurement, by 16-inch sides. Across the bottom, at the delivery end of the box, is nailed a 1-inch cleat or strip, which serves the double purpose of holding the lower part of the gauge-box in place and of raising the aperture above the bottom of the box. Six inches above the upper surface of this cleat is a wooden bar nailed across the box and parallel to the cleat beneath. The bar is 3 inches high, and is roughly marked at intervals of 1 inch across the upper edge of the supply side by saw-notches, which may be numbered by pencil-marks. The orifice is therefore 6 inches high, and when fully open is 48 inches wide. If the water in the box rises to the top of the cross-bar, the head is 3 inches above the top of the orifice, or 6 inches above its center. Each inch in width of the aperture delivers 6 miner's inches, or a total of 288 miner's inches for the cross-section of the whole aperture. The quantity of water allowed to pass through the box is determined by a gauge-board split to the required width and inserted vertically behind the cross-bar and bottom cleat, which hold it in position. In using the box in a ditch any space outside of it is securely caulked with clay. It is a convenient form of movable gauge, which may be modified to accord with any of the various accepted definitions of the miner's inch.

CHAPTER V.—AMALGAMATING MILLS.

RELATIVE AMOUNT OF ORE MILLED.—A considerably larger amount of ore is treated by the various processes depending on amalgamation than is smelted or leached. In California amalgamating mills altogether outrank the smelting establishments, but are supplemented in many cases by lixiviation works. In Nevada the Eureka smelting district is the principal exception to the rule, 78,807 out of the total 346,331 tons treated in the whole state during the census year having been worked at Eureka. In Colorado, however, less ore was milled than smelted during the same period, the respective totals being 131,948 tons milled, as against 179,564 tons smelted. In Montana, out of a total of 86,576 tons reduced during the census period, 71,896 tons were worked in amalgamating mills. Oregon, Dakota, and Wyoming ores are treated by amalgamation. Until lately all the ores in Idaho were milled, but the discovery of important base-metal districts has given an impulse to smelting operations. Mills take precedence in Arizona. In general, it may be said that, wherever practicable, owing to the peculiar economic conditions prevailing in the far West, the amalgamation process is adopted in preference to smelting from motives of economy in first cost of plant and in actual treatment, though, on the other hand, the percentage of precious metals saved by the mills is usually much lower than the results reached in smelting works.

CAPACITY OF MILLS.—The quantity of the ore which can be treated per month varies from 50 tons to several thousand, according to the quality of the ore and the size of works. Among large mills the Homestake gold mill has a capacity of 325 tons and the California silver mill 380 tons in twenty-four hours. Some of the mills are kept steadily at work from one year's end to the other, but many of them are only running for a few weeks at a time.

OWNERSHIP.—The large mills are usually owned and operated by mining companies, though a few custom mills of considerable size are reported, and on the Comstock the greater number of mills are owned by companies which are engaged exclusively in milling. Of the custom mills, nearly all were built by mining companies, and have passed, from failure of the mines or other causes, into private hands.

TENOR OF ORE TREATED.—The range in the assay value of the ore treated is very great, extraordinary facilities and a large plant permitting ore to be worked in some places at a profit which under other conditions could only be treated at a loss. The physical character of the ore also varies greatly, the quartz in some districts being extremely coherent and tough and in others friable. Some ores are so soft that 10 tons per 24 hours can be crushed with a single stamp. The predominating color in chloride or oxidized ores is a dull reddish yellow, and in sulphuret ores various shades of gray.

The ore treated by silver mills contains nearly every known silver mineral, the specimens collected in connection with the present census embracing an almost complete list of even the rarer species. What are known as free ores, if from near the surface and exposed to atmospheric agencies, contain chloride or horn-silver (cerargyrite) and more rarely native silver, or sulphide (argentite) if from below the water line, although the latter mineral is also found at or near the surface. In ores which require a preliminary roasting stephanite, tetrahedrite, polybasite, pyrargyrite, proustite, etc., are found; in fact, the ores containing silver, and also sulphur, copper, lead, antimony, arsenic, or zinc, are met with in almost endless variety. The most common gangue is quartz, with or without calc-spar and other minerals. As exceptions may be mentioned White Pine, Nevada, where the gangue is siliceous limestone; El Dorado cañon, where it is calc-spar and chlorite; and Silver Reef, Utah, where it is sandstone. Fluorspar and barite, as well as many other minerals, occur occasionally as the gangue of lodes. In some places the association of minerals is a very remarkable one; for instance, in the Spanish Belt district, Nevada, cinnabar is found in silver-bearing tetrahedrite, and at the Hackberry mine, Arizona, free sulphur was found in the oxidized chloride ore of a silver mine.

Gold is generally found in the ore in a free state, though frequently it is so intimately mixed with iron sulphurets that it is difficult of amalgamation. At other times the gold is so extremely fine that it is carried off on the water before it can be amalgamated. It is often supposed that a sulphuret of gold is found in some mines, and that "coated" gold, or gold which cannot be amalgamated in the ordinary way, exists is a matter of fact; but there is little authority for the belief that sulphur is chemically combined with gold in these ores.

FORCE EMPLOYED.—A 20-stamp wet-crushing silver mill, running 24 hours per day, generally needs the following crew of men:

2 rock-breaker men.
2 battery feeders.
2 amalgamators.
2 amalgamators' helpers.
2 engineers (and in some cases 2 firemen).
1 roustabout.
1 foreman and assayer.

A somewhat larger mill would only require an increase of a hand or two, and a smaller mill, even a 5-stamp one, could not run with a much smaller force. The usual crew for a 20-stamp gold mill is five men.

As an example of the force required by a 20-stamp dry-crushing silver mill, the pay-roll of the Grand Prize mill, at Tuscarora, Nevada, may be quoted. This mill is run by a very strong crew. Some of the more recently constructed dry-crushing mills, which have more automatic appliances, such as continuous rotary driers in place of kilns, dispense with a few hands.

TABLE XCVIII.—FORCE EMPLOYED AT THE GRAND PRIZE 20-STAMP DRY-CRUSHING AND CHLORIDIZING MILL.

Class. (a)	Average number employed.	Length of shift.	Wages per shift.	Total number of hours' work per day.	Total wages per day.
Total	28	*Hours.*		336	$121 00
Amalgamators	2	12	$5 00	24	10 00
Amalgamators' helpers	2	12	4 00	24	8 00
Chloridizers	2	12	5 00	24	10 00
Chloridizers' helpers	2	12	4 00	24	8 00
Battery feeders	2	12	5 00	24	10 00
Engineers	2	12	5 00	24	10 00
Firemen	4	12	4 00	48	16 00
Melter and retorter	1	12	4 00	12	4 00
Dry-kiln men	6	12	4 00	72	24 00
Blacksmith	1	12	5 00	12	5 00
Laborers	4	12	4 00	48	16 00

a The assayer and foreman are included in staff.

In Tuscarora district there are two other mills, each of 10 stamps, the daily pay-rolls of which are added by way of comparison. Of these the Independence-Navajo is a dry-crushing and chloridizing-roasting mill, while the Lancaster, which runs on chloride ore, crushes dry, but amalgamates raw.

TABLE XCIX.—FORCE EMPLOYED AT THE INDEPENDENCE-NAVAJO 10-STAMP DRY-CRUSHING AND CHLORIDIZING MILL.

Class. (a)	Average number employed.	Length of shift.	Wages per shift.	Total number of hours' work per day.	Total wages per day.
Total	16	*Hours.*		192	$71 00
Battery feeders	2	12	$4 50	24	9 00
Dry-kiln men	4	12	4 00	48	16 00
Chloridizers	2	12	5 00	24	10 00
Chloridizers' helpers	2	12	4 00	24	8 00
Amalgamators	2	12	5 00	24	10 00
Engineers	2	12	5 00	24	10 00
Firemen	2	12	4 00	24	8 00

a The assayer and foreman are included in staff.

TABLE C.—FORCE EMPLOYED AT THE LANCASTER 10-STAMP DRY-CRUSHING AND RAW-AMALGAMATING MILL.

Class. (a)	Average number employed.	Length of shift.	Wages per shift.	Total number of hours' work per day.	Total wages per day.
Total	16	*Hours.*		192	$69 00
Engineers	2	12	$5 00	24	10 00
Firemen	3	12	4 00	36	12 00
Battery feeders	2	12	4 50	24	9 00
Amalgamators	2	12	5 00	24	10 00
Amalgamators' helpers	2	12	4 00	24	8 00
Drier tenders	2	12	4 00	24	8 00
Laborer	1	12	4 00	12	4 00
Sage-brush wheelers	2	12	4 00	24	8 00

a The assayer and foreman are included in staff.

WAGES PAID.—The wages for mill employés range from $2 to $5 for twelve-hour shifts, and seem to be in proportion to the wages paid miners in the district where the works are situated. As a rule, mill employés receive about 10 per cent. more than miners, the difference in the length of their shifts (which for mill hands is almost invariably twelve hours) entitling them to more pay. In one or two districts mill hands were paid less than miners, however. Chinese are employed to some extent, and receive from $1 to $2. They work generally as laborers. Foremen are paid from $4 to $10 per day. The scale of wages paid in the Comstock mills is appended:

TABLE CI.—RATE OF WAGES OF DIFFERENT CLASSES OF EMPLOYÉS IN THE COMSTOCK MILLS.

Class.	Wages per shift.
Agitator men	$3 50
Amalgamators	4 00
Blacksmiths	5 00
Blanket sweepers	3 00 to 3 50
Carpenters	5 00 to 6 00
Chargers	3 50 to 4 00
Driers	4 00
Engineers	5 00 to 7 00
Feeders	3 00 to 4 00
Firemen	4 00
Foremen	5 00 to 6 00
Laborers	3 00 to 4 00
Masons	6 00
Oilers	3 50 to 4 00
Panmen	4 50 to 5 00
Retorters	3 50 to 4 00
Refiners	4 00 to 4 50
Tankmen	3 50 to 4 00
Teamsters	3 50
Watchmen	3 50 to 4 00
Woodmen	3 50

Illustrative tables are appended, showing the classification of the employés in the Comstock mills according to occupation and nationality. Of the 339 men whose nationality is recorded, 8 are classed with the staff and are omitted from the table of occupations.

TABLE CII.—NUMBER OF MEN OF DIFFERENT CLASSES EMPLOYED IN THE PRINCIPAL COMSTOCK MILLS, EXCLUSIVE OF STAFF: 1880.

Mill.	Number of men employed.	Amalgamators.	Acid makers.	Battery feeders.	Blacksmiths.	Blanket sweepers.	Bluestone makers.	Bullion refiners.	Carpenters.	Cooks and waiters.	Engineers.	Firemen.	Foremen.	Laborers.	Lead burners.	Machinists.	Metal roasters.	Millwrights.	Oilers.	Retorters.	Tankmen.	Teamsters.	Watchmen.
Total	a331	27	2	3	10	17	1	3	5	5	22	6	5	140	1	3	5	1	7	3	50	9	6
Brunswick	40	4	....	....	2	4	....	....	1	....	....	....	....	9	....	....	....	....	2	2	14	1	1
California	72	7	....	....	1	8	....	....	1	....	4	3	3	33	....	2	....	....	2	....	6	....	2
Excelsior	12	....	....	....	....	....	....	....	....	1	2	....	1	8	....	....	....	....	....	....	....	....	....
Franklin	15	2	....	....	2	2	....	....	1	....	....	....	....	8	....	....	....	....	....	....	....	....	....
Lyon	46	....	2	....	1	....	1	....	....	3	....	3	1	23	1	....	5	....	....	....	....	6	....
Mariposa	18	3	....	....	....	....	....	....	....	....	3	....	....	7	....	1	....	....	....	....	4	....	....
Morgan	33	2	....	....	2	1	....	....	1	....	3	....	....	9	....	....	....	....	3	1	10	1	....
Omega	12	....	....	....	....	....	....	3	....	....	....	....	....	7	....	....	....	....	....	....	....	....	2
Scorpion G. and S. M. Co. (b)	26	4	....	3	....	2	....	....	....	1	5	....	....	7	....	....	....	1	....	....	2	1	....
Trench	26	3	....	....	1	....	....	....	....	....	3	....	....	4	....	....	....	....	....	....	14	....	1
Woodworth	31	2	....	....	1	....	....	....	1	....	2	....	....	25	....	....	....	....	....	....	....	....	....

a In addition to the number of men here classified there were employed at other mills, which were either idle or running but a short time, 66 men, as watchmen, laborers, etc. The total amount paid as wages during the census year by the Comstock mills was $372,767 19.

b Includes Boston and Douglas mills.

TABLE CIII.—NATIONALITY OF MEN EMPLOYED IN THE PRINCIPAL COMSTOCK MILLS, INCLUDING STAFF: 1880.

Mill.	Number employed.	Americans.	Azores islands.	Belgians.	Canadians.	Channel islands.	Chinese.	Danes.	English.	French.	Germans.	Irish.	Italians.	Newfoundland.	Norwegians.	Nova Scotians.	Portuguese.	Russians.	Scotch.	Slavonians.	Swedes.	Swiss.	Welsh.
Total	320	115	1	1	26	1	29	12	13	1	16	77	2	2	2	4	10	1	5	2	5	3	1
Brunswick	41	17	....	....	7	....	....	1	2	....	2	10	....	....	....	....	....	....	....	2	....	....	....
California	72	20	....	1	5	....	....	....	2	....	5	28	1	....	....	1	2	1	2	....	2	2	....
Excelsior	12	3	....	....	2	....	1	....	....	....	3	2	....	....	....	....	2	....	....	....	....	....	....
Franklin	16	7	....	....	1	....	....	3	....	1	1	2	....	....	....	....	....	....	1	....	....	....	....
Lyon	48	17	1	....	5	1	14	....	3	....	1	3	....	....	1	....	2	....	....	....	....	....	....
Mariposa	18	6	....	....	3	....	....	2	....	....	2	4	....	....	....	1	....	....	....	....	....	....	....
Morgan	34	5	....	....	2	....	....	5	4	....	3	8	....	....	1	1	....	....	2	....	2	1	....
Omega	13	3	....	....	5	....	....	....	....	....	....	4	....	....	....	....	....	....	....	....	....	....	....	1
Scorpion G. and S. M. Co. (a)	26	14	....	....	....	....	1	....	....	....	....	5	....	....	....	1	4	....	....	....	1	....	....
Trench	27	10	....	....	5	....	....	....	1	....	....	9	....	2	....	....	....	....	....	....	....	....	....
Woodworth	32	13	....	....	1	....	13	1	1	....	....	2	1	....	....	....	....	....	....	....	....	....	....

a Includes Boston and Douglas mills.

RELATION OF LABOR TO PRODUCT.—An analysis of the results reached in 160 mills shows that for every ton of ore crushed the labor of one man for 3.9 hours, costing $1 34, is required. For the separate establishments the range is very great, depending upon the character of the ore and the treatment and upon the efficiency of the machinery, while wide variations are found in the averages for the different states and territories. The most economical process in point of labor, as in other details, is the treatment of free-milling gold ores by large wet-crushing mills; the most expensive, that of reducing base silver ores, which require chloridizing-roasting as a preliminary to pan amalgamation. Dakota, where the ores worked are exclusively of gold, and California and Oregon, where such ores largely predominate, are therefore the localities where the greatest saving in labor is effected; while Arizona, Nevada, and Montana show a much greater expenditure of labor, as would be expected, in view of the character of their ores. In Colorado and Idaho the different classes of mills are nearly balanced, and the labor employed in crushing a ton of ore closely approximates the average for the whole country. It should be observed that while in tonnage the gold mills take the lead, the silver mills treat ore of a higher grade, so that a comparison based upon the bullion product would show somewhat different results.

To produce a dollar in gold bullion costs 8 cents for mill labor in Dakota; in Nevada, though over five times as much work is required per ton treated, the cost for mill labor per dollar of silver bullion produced is 7 cents, or practically the same proportion. The following table shows the average number of hours' work and cost of labor per ton of ore crushed in the principal mining states and territories, and is based on the treatment of nearly a million and a half tons:

TABLE CIV.—AMOUNT AND COST OF LABOR IN AMALGAMATING MILLS.

State or territory.	Number of mills.	Tons treated.	Total number of men employed.	Foremen.	Amalgamators.	Day laborers.	Other workmen.	Total number of hours' work done during the year.	Total sum paid on labor account, exclusive of staff.	Average number of hours per ton crushed.	Average amount paid for labor per ton crushed.
Total	160	1,467,478.75	2,046	101	302	657	986	5,745,785	$1,973,906 00	3.915	$1.345
Arizona	11	15,946.40	137	3	23	64	47	300,340	71,717 00	12.563	4.497
California	33	419,883.50	301	13	76	147	65	1,078,742	291,577 00	2.569	0.694
Colorado	28	140,117.35	197	23	22	57	95	579,374	146,024 00	4.137	1.042
Dakota	22	506,238.00	259	13	35	147	64	835,001	251,759 00	1.629	0.497
Idaho	7	16,391.25	50	1	8	9	41	70,128	22,017 00	4.278	1.343
Montana	13	47,801.00	144	9	17	62	56	373,746	191,609 00	7.819	4.008
Nevada	33	287,604.75	742	34	96	147	465	2,063,813	736,149 00	8.686	3.111
Oregon	5	12,437.00	27	2	6	14	5	41,684	10,250 00	3.352	0.824
Utah	8	71,059.50	180	3	19	10	148	512,757	249,804 00	7.216	3.515

POWER.—The proportion which the horse-power of the engine bears to the stamp seems to be as follows:

For gold mills, from 2 to 3 horse-power.
For wet-crushing silver mills, from 5 to 6 horse-power.
For dry-crushing silver mills, from 6 to 7 horse-power.

These figures are only approximate, as the data in regard to the horse-power of engines in different mills are no doubt in many cases incorrect, and the horse-power is not only governed by the size of machinery, but also by the number of stamps, etc., a small mill requiring proportionately more horse-power to the stamp than a large one.

The pressure of steam ordinarily maintained in the boilers is about 80 pounds; but in some few mills it is 90 pounds, and even as high as 100 pounds. Very few boilers are run with a pressure of less than 70 pounds.

Water-power is also used in many mills, and where practicable is much more economical than steam. Some mills are fitted with both steam-engines and water-wheels, the former being brought into use when the latter are unavailable, as in case of drought or freezing. The water-motors are turbines of the Leffel or Knight patterns, overshot wheels, or more rarely hurdy-gurdy wheels.

FUEL.—The fuel used in quartz-mills is generally wood, and it is of many different kinds and qualities. In some mills in Nevada sage-brush is used under the boilers. The leading kinds of wood are: mountain mahogany, weighing from (*a*) 3,200 to (*b*) 4,400 pounds per cord; mesquit, weighing from 2,500 to 3,500 pounds; nut-pine, with very variable weight, depending on seasoning, size, and shape of sticks, etc., may be put down at between 2,000 and 3,300 pounds; sugar-pine, from 2,000 to 2,300 pounds; cedar, 1,800 to 2,500 pounds; cottonwood, 1,500 to 2,300 pounds. As near as can be determined 156 pounds of sage-brush are equal to 100 pounds of good cedar. The averaging of different weights of the same kind of wood is impossible, as the weight of a given kind of wood depends upon the locality of its growth (which affects its grain), the seasoning, and the closeness with which it is corded.

It is almost impossible, on account of the different character of the wood burned and the differences of method and machinery, to determine the quantity of fuel consumed under the boiler in working a ton of ore. For gold mills the consumption is estimated at from one-tenth to one-fifth of a cord per stamp, while for wet-crushing silver mills three-quarters of a cord is probably the maximum, in which case the wood must needs be of a very poor kind and quality or the machinery very inefficient; the average is thought to be less than half a cord. In roasting-mills, which are always dry-crushing, about one-third of a cord is consumed to the stamp. This does not include the wood necessary for roasting, which will be mentioned later.

The fuel consumed in retorting can safely be estimated at from one-fifth to one-third of a cord to the 1,000 pounds of amalgam.

WORKING RESULTS.—The question of percentage extracted is one in regard to which the expert is obliged to depend entirely upon the statement of the mill man, and in many cases the percentage claimed is higher than the circumstances under which the ore was worked warrant. Sometimes the percentage extracted is calculated from the assay value of the tailings, a method which rarely, if ever, gives true results; often it is merely determined by guess, leaving a very liberal margin in favor of the mill man's skill.

Where silver ore is roasted, probably from 80 to 90 per cent. is extracted on the average, though a few mills have been known to work up to 96 per cent. In so-called free-milling ore generally not much over 70 per cent. is extracted, although mills in White Pine, Nevada, and Silver Reef, Utah, have worked ores to 85 per cent., and on the Comstock ore has been worked to above 80 per cent.

In gold mills there is a wide difference in the percentage extracted, but it rarely exceeds 80 per cent., and often falls much below it.

It is not possible to fix any definite figure for the average assay value of tailings and slimes. The value varies exceedingly according to richness of ore and mode of treatment.

COST OF TREATMENT.—The cost of milling gold ores in California varies from 54 cents to $2 50 per ton. Where water-power is to be had, ores can be milled very cheaply, at a cost of not more than $1; and where steam-power is necessary, exceptional facilities may reduce the expenses of working to those of the average water-power mills. In other states and territories it is as a general thing somewhat more expensive to reduce gold ores; but in the Black Hills region of Dakota the large gold mills are operated very cheaply, in spite of high freights and other disadvantages, because of the simplicity of the process, the scale upon which operations are carried on, and the economy in labor which is affected by the use of automatic labor-saving devices.

The cost of milling silver ores in wet-crushing is from $4 to $8; in dry-crushing from $6 to $12. With ores which require roasting it is from $12 to $28. There are, of course, circumstances where these figures are exceeded, and sometimes it may be possible to work ores at less cost than the lowest prices given. The great difference in ores, in the facilities for working, and in the methods of extracting the precious metals, render it impossible to make a general statement as to the cost of the process.

REDUCIBILITY OF VARIOUS ORES.—Those ores can be most cheaply worked which contain silver as chloride without base metals or carry gold unmixed with sulphurets. As instances of particularly free-milling silver ores

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a This weight is from data of the Eureka and Palisade railroad.
b This weight is from data of the Richmond Mining Company.

those of White Pine, in Nevada, and Silver Reef, in Utah, may be mentioned. Next in order come those ores which, although they contain chloride of silver, are mixed with lead (generally in the form of carbonate) and various copper, arsenic, and antimony minerals. The ore of the Comstock, although it contains but little base metal, may be classed under this head, as most of its silver is in the form of sulphide and a part of the gold is contained in the iron pyrites. It mills from 70 to 80 per cent. The last and most difficult class of ores to work comprises the many complex sulphides of silver and other elements; and although it is almost invariably necessary to roast these ores, some of them (such, as are composed of quartz, silver sulphide, and a little iron and copper pyrites) can be roasted and worked at a cost not much in excess of that of the baser free-milling ores, and certainly to better advantage, as at least 90 per cent. of the assay value can thus be extracted. But these ores are very rarely met with, and by far the larger class is that in which the ore either does not contain enough sulphur to render the chloridation complete or contain large quantities of the sulphides of zinc, antimony, and arsenic, and can therefore be roasted only at the expense of much time, care, and money. Such are those of Morey, in Nevada, and many in Arizona. Frequently mistakes in deciding upon the proper plant and process to work ores are made, as it is often a delicate matter to decide whether an ore can be best milled or smelted, and, if milled, whether it requires roasting. The mining country is covered over with reduction works which are failures, owing to the wrong method having been chosen to work the ores. Such disappointments are of rare occurrence nowadays, more prudence and experience being brought to bear on this class of investment than was formerly the case.

TERMS OF CUSTOM MILLS.—The prices charged for reducing ores are generally one-quarter to one-half as much again as the actual cost, or even more, except with such milling companies as own mines, which they lease to miners, expecting to make their profit out of the "tribute" and not out of the mill.

Usually gold mills do not guarantee any percentage. In silver mills, where the ore is worked raw, the guarantee is from 70 to 80 per cent. of the assay value. Sometimes a "clean up" is given; that is, after the ore is worked, the bullion product is gathered together and turned over to the ore owners, who pay the charges for working. When ore needs roasting, the mill generally guarantees 80 per cent.; sometimes, as in Austin, 80 per cent. on such ore only as assays over a certain fixed value. Where a percentage is guaranteed, the tailings, slimes, etc., are looked upon as belonging to the mill company; but when ore has been worked on the "clean up" plan they are generally regarded as belonging to the mining company, unless there has been a previous agreement in reference to them. In purchasing ores, the percentage of the assay value offered is paid after deducting the price of milling.

When custom ore is worked the mine almost always pays for the hauling of the ore to the mill. Ore is usually transported by wagon or on pack animals, and sometimes by a tramway or a railroad.

TENOR OF BULLION.—The quality of bullion produced is, of course, very varied. In gold mills the fineness usually runs from 0.600 to 0.850 in gold (the maximum reported was 0.920), silver constituting most of the balance of the bullion. In silver mills the bullion has a much wider range of fineness, running from 0.050 (as was the case with a little of the bullion at the Meadow Valley mill, in Pioche) up to 0.999. Among instances of fine silver bullion may be mentioned that of the Comstock and of White Pine, in Nevada, and that of Silver Reef, in Utah. In these places it does not often run below 0.990, and often as high as 0.999. The quality of bullion depends generally upon the character of the ore, but sometimes upon the method of working. For instance, some base ores, in which most of the silver is in the form of chloride, can be made to produce bullion 0.900 fine and upward by amalgamating cold or rather not hot, or by using the minimum of salt and little or no bluestone. With such ores it is much better to keep the bullion at from 0.600 to 0.700; for, although the silver of the chloride is the first metal amalgamated, the sulphide silver minerals remain, unamalgamated, with the base-metal compounds.

The only base metals which are found to any extent in the amalgam are lead and copper. Iron in some quantity is occasionally found, but its presence is owing to a mechanical mixture of particles worn from the battery and pans, and not to any chemical process. Sulphurets containing zinc, antimony, arsenic, and some other metals also enter into the amalgam in the same way, but by adding quicksilver to the amalgam and washing in a clean-up pan these sulphurets and the iron can be removed.

DISPOSITION OF BULLION.—Bullion is usually shipped to the New York or San Francisco markets through Wells, Fargo & Co. and other express companies. The charges vary from ½ to 2½ per cent., the discount being governed by the market value of silver and the quality of the bullion.

STAMP-BATTERIES.

WET AND DRY CRUSHING.—For gold ore the wet-crushing battery is exclusively used, and for free-milling silver ore it is also generally employed. In some cases, as at Eberhardt, in White Pine, and the Lancaster mill, at Tuscarora, dry-crushing is practiced on the ground that a much higher percentage is saved, owing to the avoidance of loss of finely divided horn-silver in the slimes, which is apt to occur when the ore is crushed wet. This is highly probable with chloride ore, for, although the slimes are very thin, the earthy material in them seems to be richer in silver than the ore itself. There are also some ores which, when crushed, produce so much slime that it is impossible to keep a reasonable percentage of pulp in the mill. For such ores dry-crushing is preferable; but for other free-milling ores wet-crushing is by far the best, as more ore can be crushed, there is less wear and tear on the

battery per ton, and the hands are not subjected to that inconvenient and unhealthy dust which everywhere pervades the atmosphere of a dry-crushing mill, in spite of attempts made to get rid of it. To a certain extent the advantages of dry-crushing and wet-crushing for free-milling ores are combined in the plan adopted at Bodie and elsewhere of pumping back the water from the settling-tanks into the battery. When it is intended to roast ore, it is always crushed dry.

WHERE BUILT.—The machinery of most of the mills in operation on the Pacific coast has been constructed in San Francisco; the plant of some mills, however, has been brought from the East, and of the latter Chicago has furnished a large proportion. Recently the work of the eastern foundries which turn out mining and milling machinery has improved greatly in quality; and, aided by the cheapness of labor and of material, they have been able to compete with San Francisco and other Pacific coast establishments, even at a relative disadvantage in point of freight charges. As a rule, the types of machinery in vogue have originated and have been developed in works in the neighborhood of the mines, and these establishments have shown much enterprise in adopting new improvements. Latterly, however, since the manufacture of mining and milling machinery has grown to be an industry of importance in the East, novelties and improvements are to be found in the product of the eastern works. Innumerable worthless inventions have also issued from all points at which mining machinery is manufactured.

SIZE OF MILLS.—Among the large mills may be mentioned the following: In California, the Empire (80-stamp), in Amador county, and the Plumas-Eureka (88-stamp), in Plumas county. In Nevada, the California (80-stamp), at Virginia City. In Dakota, the Homestake old (80-stamp) and new (120-stamp) mills, in Whitewood district, and the Father de Smet (80-stamp), in Lost Placer district. In Colorado, the Black Hawk (125-stamp), of Gregory district. In Arizona, the Central Arizona (80-stamp) mill, at Vulture, Maricopa county. There is, on the other hand, a steam battery of two stamps at Globe, Arizona, and a Huntington double-stamp battery at Queen's River, Idaho, while a single-stamp battery, the Kendall, is being introduced for prospecting tests. The largest mills, as gauged by the number of stamps only, are as a rule gold mills, though there are several 40- and 60-stamp silver mills, beside the California (80-stamp), above mentioned.

The most common size for a mill seems to be 20 stamps; it is also a very convenient size, especially for a roasting mill. The size, of course, ought to be governed by the quantity of ore available; but this is not always the case, for mills have been built where there was no ore, and often where the crushing capacity was vastly in excess of any probable output of the adjacent mines.

NUMBER OF STAMPS PER BATTERY.—Five is the usual number of stamps per battery, though some of the older mills have but four. The Gold Stripe mill, in Plumas county, California, has six. Millmen are commonly of the opinion that an even distribution of pulp in a mortar can only be secured with an odd number of stamps, and of such numbers five is on several accounts the most convenient.

WEIGHT OF STAMPS.—In new mills the usual weight of stamps is from 700 to 800 pounds each, though great variations still occur in practice. As will be seen from the subjoined tables, the range in weight is from 300 to 1,050 pounds. The average for 280 mills reported on, having 5,367 stamps, is 689 pounds. The heaviest batteries, as a rule, are to be found in Nevada, and the lightest in Alabama and Georgia. Of the important mining states Colorado appears as the locality where light stamps are most in vogue.

TABLE CV.—STAMP BATTERIES: NUMBER AND WEIGHT OF STAMPS.

County and district.	Number of mills reported.	Number of stamps.	Maximum weight of stamps.	Minimum weight of stamps.	Average weight of stamps.
ALABAMA.					
CLEBURNE CO.			*Pounds.*	*Pounds.*	*Pounds.*
Third	1	8	400	350	375
TALLADEGA CO.					
T. 19, R. 6	1	8	300	300	300
ARIZONA.					
MARICOPA CO.					
Globe	2	7	1,000	750	821
MOHAVE CO.					
Cedar Valley	1	5	750	750	750
Hualapai	1	5	950	950	950
Owens	2	30	850	850	850
PIMA CO.					
Arivaca	2	30	750	350	483
Tombstone	3	45	900	750	850
PINAL CO.					
Globe	1	5	900	900	900
Pioneer	2	25	750	750	750
ARIZONA—Continued.					
YAVAPAI CO.			*Pounds.*	*Pounds.*	*Pounds.*
Cherry Creek	1	10	850	850	850
Peck	1	10	850	850	850
Pine Grove	1	10	750	750	750
Tiger	1	10	950	950	950
	1	10	800	800	800
CALIFORNIA.					
AMADOR CO.					
Amador City	2	80	800	750	775
Jackson	1	80	750	750	750
Plymouth	1	80	750	750	750
Sutter Creek	1	40	640	640	640
CALAVERAS CO.					
Washington	1	10	600	600	600
Independence	1	10	500	500	500
Mokelumne Hill	1	60	650	650	650
EL DORADO CO.					
Placerville	1	20	750	750	750
Springfield	1	10	650	650	650

TABLE CV.—STAMP BATTERIES: NUMBER AND WEIGHT OF STAMPS—Continued.

County and district.	Number of mills reported.	Number of stamps.	Maximum weight of stamps.	Minimum weight of stamps.	Average weight of stamps.
CALIFORNIA—Continued.					
INYO CO.			*Pounds.*	*Pounds.*	*Pounds.*
Russ	1	30	600	600	600
LASSEN CO.					
Hayden Hill	3	20	650	600	625
MARIPOSA CO.					
Mariposa Estate	1	40	750	750	750
MONO CO.					
Blind Spring	1	5	750	750	750
Bodie	6	120	800	530	749
NEVADA CO.					
Grass Valley	1	50	850	850	850
Nevada City	2	38	750	750	750
PLACER CO.					
Colfax	1	10	800	800	800
PLUMAS CO.					
Genesee Valley	1	10	750	750	750
Indian Valley	4	96	765	700	738
Quartz township	1	85	800	800	800
Seneca	1	5	650	650	650
SAN BERNARDINO CO.					
Clark	2	15	750	600	650
SAN DIEGO CO.					
Cargo Muchacho	1	20	950	850	900
Julian	1	5	650	650	650
SHASTA CO.					
Pittsburgh	1	10	900	900	900
SISKIYOU CO.					
Quartz Valley	1	10	600	600	600
Sawyer's Bar	1	32	650	650	650
South Fork Salmon	1	32	650	650	650
TUOLUMNE CO.					
Confidence	1	40	750	750	750
Soulsbyville	1	15	750	750	750
COLORADO.					
BOULDER CO.					
Central	1	25	a 450	a 450	a 450
Gold Hill	1	10	750	750	750
Grand Island	1	15	650	650	650
Ward	2	70	650	450	583
	1	5	750	750	750
CLEAR CREEK CO.					
Griffith	2	30	750	650	700
Idaho	1	25	650	650	650
Morris	1	12	500	500	500
Upper Union	1	16	500	500	500
CUSTER CO.					
Hardscrabble	1	20	650	650	650
GILPIN CO.					
Enterprise	8	223	550	400	490
Eureka	1	20	550	550	550
Gregory	6	250	600	550	570
Nevada	8	114	600	500	526
LAKE CO.					
California	1	15	750	750	750
RIO GRANDE CO.					
Summit	1	10	530	530	530
SUMMIT CO.					
Avalanche	1	15	525	525	525
SAN JUAN CO.					
Animas	1	10	750	750	750
DAKOTA.					
LAWRENCE CO.					
Bear Butte	2	20	700	650	675
Lost Placer	1	80	750	750	750
Whitewood	30	740	800	550	693
GEORGIA.					
CHEROKEE CO.			*Pounds.*	*Pounds.*	*Pounds.*
Third and Second	1	5	400	400	400
	1	5	400	400	400
COBB CO.					
	1	10	500	500	500
FORSYTH CO.					
Third and First	1	5	650	650	650
HALL CO.					
Ninth	2	15	1,050	625	900
HARALSON CO.					
Eighth	1	10	400	400	400
LINCOLN CO.					
Goshen	1	8	300	300	300
LUMPKIN CO.					
Twelfth and First	9	145	500	450	473
Thirteenth	1	10	450	450	450
MCDUFFIE CO.					
Republican	1	5	550	550	550
MERIWETHER CO.					
Lutherville 1281	1	10	350	350	350
OGLETHORPE CO.					
Simston	1	10	650	650	650
WHITE CO.					
Third Land	1	20	450	450	450
Fourth Militia	1	10	700	700	700
WILKES CO.					
Bussey	1	10	750	750	750
178	1	5	450	450	450
	1	5	525	525	525
IDAHO.					
ALTURAS CO.					
Bonaparte	1	20	630	630	630
Middle Boisé	4	40	650	650	650
Queen's River	1	3	850	850	850
Rocky Bar, or Bear Creek	1	10	650	650	650
BOISÉ CO.					
Banner	1	20	650	650	650
Elkhorn	1	5	700	700	700
Gambrinus	1	10	650	650	650
Granite	3	85	800	700	729
Mammoth	2	16	700	550	625
Shaw's Mountain	1	10	550	550	550
LEMHI CO.					
Yankee Fork	1	20	825	825	825
OWYHEE CO.					
Carson	6	75	900	628	674
Wagontown	2	20	650	650	650
MAINE.					
HANCOCK CO.					
Sullivan	1	10	750	750	750
MONTANA.					
BEAVER HEAD CO.					
Bald Mountain	1	6	650	650	650
Bannock	1	5	650	650	650
	1	6	750	750	750
DEER LODGE CO.					
Flint Creek	2	30	750	650	683
McClellan Gulch	1	5	600	600	600
Silver Creek	1	40	650	650	650
Summit Valley	8	98	750	550	675
JEFFERSON CO.					
Cedar Plains	1	10	600	600	600
Elkhorn	1	5	650	650	650
	1	30	650	650	650

a Estimated.

TABLE CV.—STAMP BATTERIES: NUMBER AND WEIGHT OF STAMPS—Continued.

County and district.	Number of mills reported.	Number of stamps.	Maximum weight of stamps.	Minimum weight of stamps.	Average weight of stamps.
MONTANA—Continued.					
LEWIS AND CLARKE CO.			*Pounds.*	*Pounds.*	*Pounds.*
Silver Creek	1	85	750	600	675
Stemple	8	25	700	650	670
MADISON CO.					
Hot Spring	1	5	650	650	650
Mineral Hill	1	10	800	800	800
Silver Star	2	24	688	550	539
NEVADA.					
ELKO CO.					
Columbia	1	10	1,010	1,010	1,010
Tuscarora	8	40	800	750	787
ESMERALDA CO.					
Black Mountain	1	10	800	800	800
Columbus	2	40	900	900	900
Esmeralda	1	8	400	400	400
Oneota	1	4	650	650	650
Pine Grove	2	20	750	750	750
Wilson	1	10	800	800	800
EUREKA CO.					
Cortez	1	10	700	700	700
HUMBOLDT CO.					
Mount Rose	2	20	950	950	950
Sierra, or Dun Glen	1	10	750	750	750
Winnemucca	2	20	800	750	775
LANDER CO.					
Lewis	1	15	850	750	800
Reese River	1	30	1,000	1,000	1,000
LINCOLN CO.					
Eldorado	1	15	700	700	700
Ely	1	30	750	750	750
Pahranagat	1	10	a750	a750	a750
NYE CO.					
Morey	1	10	800	800	800
Tybo	1	20	700	700	700
Union	1	40	850	850	850
STOREY, LYON, AND ORMSBY COS.					
The Comstock	14	469	984	750	839
WHITE PINE CO.					
Cherry Creek	1	20	a800	a800	a800
Ward	1	20	750	750	750
White Pine	1	80	750	750	750
NEW MEXICO.					
DOÑA ANA CO.					
Hillsborough	1	10	550	550	550
GRANT CO.					
Silver Flat	2	30	750	600	675
NORTH CAROLINA.					
GASTON CO.					
.....	1	40	750	750	750
GUILFORD CO.					
.....	1	5	850	850	850
NORTH CAROLINA—Cont'd.					
MECKLENBURG CO.			*Pounds.*	*Pounds.*	*Pounds.*
Capp's Hill	1	10	650	650	650
Sixth	1	10	750	750	750
MOORE CO.					
.....	1	10	750	750	750
OREGON.					
BAKER CO.					
Burnt River	2	10	750	600	675
Conner Creek	1	20	600	600	600
Rye Valley	1	5	900	900	900
.....	1	20	650	650	650
GRANT CO.					
Granite	1	10	800	800	800
UTAH.					
JUAB CO.					
Tintic	2	42	750	750	750
SALT LAKE CO.					
West Mountain	1	20	650	650	650
SUMMIT CO.					
Uintah	1	40	850	850	850
TOOELE CO.					
Camp Floyd	1	20	750	750	750
Rush Valley	1	5	a750	a750	a750
UTAH CO.					
Tintic	1	10	750	750	750
WASHINGTON CO.					
Harrisburgh, or Silver Reef	4	30	850	650	758
VIRGINIA.					
BUCKINGHAM CO.					
Cardsville	1	5	750	750	750
CULPEPER CO.					
.....	1	10	550	550	550
FAUQUIER CO.					
.....	1	10	650	650	650
LOUISA CO.					
Cochoe	1	10	650	650	650
STAFFORD CO.					
Hartwood	1	10	750	750	750
WYOMING.					
CARBON CO.					
Douglass	1	10	640	640	640
SWEETWATER CO.					
California	5	50	850	350	618
Miners' Delight	3	30	800	750	770

a Estimated.

TABLE CVI.—STAMP BATTERIES: NUMBER AND WEIGHT OF STAMPS—RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	Number of mills reported.	Number of stamps.	Maximum weight of stamps.	Minimum weight of stamps.	Average weight of stamps.	State or territory.	Number of mills reported.	Number of stamps.	Maximum weight of stamps.	Minimum weight of stamps.	Average weight of stamps.
			Pounds.	*Pounds.*	*Pounds.*				*Pounds.*	*Pounds.*	*Pounds.*
Total	280	5,967	1,050	300	689	Maine	1	10	750	750	750
						Montana	26	319	800	350	668
Alabama	2	16	400	300	337	Nevada	42	901	1,010	400	830
Arizona	19	202	1,000	350	781	New Mexico	3	30	750	550	639
California	48	1,031	950	500	733	North Carolina	5	75	750	350	710
Colorado	34	985	750	400	559	Oregon	6	65	900	600	681
Dakota	23	340	800	550	697	Utah	11	167	850	650	763
Georgia	26	286	1,050	300	508	Virginia	5	45	750	550	661
Idaho	24	283	900	550	674	Wyoming	9	110	850	350	686

Total weight of stamps, 3,701,204 lbs.=1,850$\frac{602}{2000}$ tons.

WEIGHT OF SHOES AND DIES.—The weight of the shoe bears a certain relation to the weight of the stem, tappet, and boss. For a stamp which weighs 800 pounds the shoe should weigh about 125 pounds and the die say 100 pounds. Some millmen advocate a very thick die; but the one great objection to this plan is that the loss of crushing power when the level of the die surface is worn much below the discharge more than compensates for the gain in time and material in changing dies less often, and if the thick dies are set high at first the breakage of screens is much above the usual amount.

MATERIAL OF SHOES AND DIES.—Cast iron is still much more frequently used than steel for shoes and dies. Thus, of 253 mills reported, only 23 use steel exclusively and 11 both steel and iron for this purpose, or 34 use steel altogether or in part, while in 219 mills iron is the material employed. Among the best equipped mills, however, the proportion of steel shoes and dies is undoubtedly higher than is shown by these figures, for among the 34 mills using steel are some of the finest of the recently constructed works.

On the first introduction of steel for this purpose great expectations were aroused among millmen as to its superiority, but, unfortunately, many of the earlier castings sent out proved defective, and a reaction of opinion set in. The difficulty with the first steel shoes and dies seems to have been that, although they outlasted the iron shoes in the ratio of 2 to 1, many of them wore cup-shaped and chipped; but this may have been owing to the fact that the outside of steel shoes and dies, on casting, cooled more rapidly than the inside, and thereby became harder. The steel shoes and dies at present manufactured are, however, of much better quality, and usually wear very evenly, the improvement being due to a better knowledge of the requirements and greater care in casting.

The question of steel *versus* iron for shoes and dies is purely one of relative economy, and not of theoretical merits of one metal above the other. Steel lasts longer than iron, but costs proportionately more; on the other hand, a less frequent adjustment of drop is required with the more slowly-wearing material. In districts remote from railroad communication, and where the freight charges are high, steel is more economical than iron; for the first cost of material becomes a matter of less moment when the expense of transportation reaches from 3 to 5 cents per pound, as is sometimes the case. If it requires two sets of iron shoes and dies to do the work of one set of steel ones, evidently it will cost twice as much in freight charges for this item to keep a mill supplied with the former.

In many districts there are founderies, sometimes connected with mining works, which recast the worn shoes and dies, thus utilizing the old iron, but have not the facilities for producing perfect steel castings. This consideration, no doubt, has weight in the choice of material. There is also no market for the old steel, while scrap-iron, on the other hand, can be readily disposed of in most localities. In dry-crushing mills, running on very hard rock, steel is generally preferred.

The Table CVII shows the prevalent practice in the several states and territories, the reports from 253 works being grouped under three heads—mills using cast iron only, mills using steel only, or mills using both iron and steel for shoes and dies.

TABLE CVII.—STAMP BATTERIES: CHARACTER OF SHOES AND DIES.

State or territory.	Number of mills reported, with character of shoes and dies specified.	Number of mills using iron shoes and dies.	Number of mills using steel shoes and dies.	Number of mills using both iron and steel shoes and dies.
Total	258	215	23	11
Alabama	2	2	.....	.....
Arizona	17	12	4	1
California	43	31	8	4
Colorado	34	30	.....	a 4
Dakota	23	22	1	.....
Georgia	26	24	2	.....
Idaho	20	18	2	.....
Maine	1	1	.....	.....
Montana	26	25	1	.....
Nevada	24	10	8	b 2
New Mexico	3	3	.....	.....
North Carolina	5	5	.....	.....
Oregon	6	6	.....	.....
Utah	9	6	1	.....
Virginia	5	4	1	.....
Wyoming	9	9	.....	.....

a One mill uses steel dies and iron shoes, and one mill iron dies and shoes of both steel and iron.
b One mill uses iron dies and steel shoes.

The iron in use is nearly always a mixture of white and gray iron in different proportions, and is sometimes chilled and sometimes not. Of 39 mills reporting the use of chilled-iron shoes and dies specific description was received from 25, as follows, without any attempt at classification further than to quote the wording of the reports:

Gray	1	White	15
Mottled	1	White double chilled	1
Nearly mottled	1	Hard (white?)	1
White mottled	1	Common cast	2
White surface-chilled	2		

No details were received from 14 other mills reporting the use of chilled iron for this purpose. In 143 reports, in which it was not stated whether the castings were or were not chilled, the following varieties are included:

Very soft gray	1	100 parts white mottled, 25 gray, and 15 wrought iron	1
Very soft (gray?)	1	One-third No. 1 (gray) and two-thirds scrap	4
Soft gray	1	Hard white	5
Gray	3	White Scotch pig	2
Mottled	12	Woodstock white charcoal cold blast	1
Common cast	12	Car-wheel iron	1
Mottled nearly white	1	Scrap	3
White mottled	13	Hard scrap	1
Common cast low white	1	Scrap and pigs	2
Nearly white	22	Franklinite (mixed?)	8
Medium white	1		
White	47		

MATERIAL OF TAPPETS, ETC.—Steel has been introduced as the material for tappets, cams, bosses, etc., as well as for shoes and dies. It has been found to work excellently for these purposes.

LEVEL OF THE DIE BELOW DISCHARGE.—In gold mills where amalgamation is carried on in the battery the level of the die-surface is kept from 2 to 6 inches below the discharge in order to amalgamate as much gold as possible in the mortar. By means of a movable slide at the bottom of the screen the level of the discharge can be kept the same as the die wears out.

In silver mills which crush wet it is intended to keep the die-surface about 1 or 2 inches below the level of the discharge; but as the die wears down its surface is gradually lowered, and this decreases the crushing power of the battery. It is the aim of the mill man to set his die as high as possible, without endangering his screens, so as to utilize most of his die to the best advantage. In dry-crushing silver mills this is also the case, except that there is a greater loss of power in the dry than in the wet-crushing battery when the die-surface is much below the level of the discharge.

GUIDES.—Many varieties of guides have been experimented on, but the prevailing practice is to use plain wooden ones. The wood chosen is generally oak, though other hard woods answer the purpose; sometimes soft wood is employed, because of the difficulty of obtaining other kinds. At the California mill, Virginia City, both oak and hickory are used, and heart of maple, when obtainable, is recommended by some millmen. At Austin, Nevada, the cast-iron guides have square holes, which are filled with pine blocks with the grain vertical and bored out to the proper size for the stem. These blocks can be replaced at any time, and only one stamp need be hung up. At the Buffalo mill, at Atlanta, Idaho, guides of yellow pine and fir, the only woods in the district, having given much trouble by wearing out very rapidly, the superintendent, to avoid the necessity of transporting solid guides of hard wood from a distance, hit upon a similar expedient. Oak keys, four for each bearing and with the grain vertical, were mortised into the fir guide-frames, with the bearing surface turned concave to fit the stem. These keys are replaced by new ones without disturbing the frames or removing a bolt.

Some of the cast-iron guides in use are lined with babbitt-metal, and at one mill in Utah a lining of rawhide is adopted. In dry-crushing batteries babbitt-metal and brass are cut by the quartz dust. In one Nevada mill brass guides are used with part of the batteries, while iron is used in the rest; but the result of this trial, side by side, of the two styles is not reported. One mill in Colorado and one in Georgia have upper guides of wood and lower ones of iron. The following table shows the proportionate number of mills fitted with the different kinds of guides, from which it appears that in 244 of the 257 mills reported wooden guides are used exclusively:

TABLE CVIII.—STAMP BATTERIES: CHARACTER OF GUIDES.

State or territory.	Number of mills reported, with character of guides specified.	Number of mills using wooden guides.	Number of mills using iron guides.	Various.
Total	257	244	9	4
Alabama	2	2	.....	.....
Arizona	19	18	1	.....
California	43	42	1	.....
Colorado	34	33	.....	1
Dakota	23	23	.....	.....
Georgia	26	24	1	1
Idaho	20	20	.....	.....
Maine	1	1	.....	.....
Montana	26	26	.....	.....
Nevada	23	21	3	1
New Mexico	3	3	.....	.....
North Carolina	5	5	.....	.....
Oregon	6	6	.....	.....
Utah	10	9	.....	1
Virginia	5	5	.....	.....
Wyoming	9	6	3	.....

CAMS.—Double-armed cams are now used almost exclusively, but in a few of the older mills single-armed cams are still found. The advantage of the double-armed cam is obvious; the cam-shaft, which is subject to an enormous strain, can be run at one-half the speed necessary to obtain the same number of drops per minute with single cams. The attempt to carry this principle still further by adopting three-armed cams has not been successful, as the tappet has not room, in falling, to clear the rising cam-tips safely, while the latter could not be shortened without assuming a less advantageous curve.

MAXIMUM DROP.—The maximum drop obtainable is not the same in silver and gold mills, as the stamps of gold mills should drop farther than those of silver mills, in order to produce the splash which assists in battery amalgamation. In gold mills the maximum drop obtainable is from 12 to 20 inches, and in silver mills from 9 inches upward.

WIDTH OF MORTAR.—The width of the mortar at the bottom of the screen varies from 10 to 14 inches and depends upon the hardness of the ore. At the California mill, where the quartz is very friable, the width of the mortar is only 10½ inches, although the stamp weighs nearly 1,000 pounds and the shoe has a large diameter. Such a mortar could hardly be used for hard quartz, as the screens would be continually in danger. Of course the narrower the mortar the faster the battery will discharge.

DOUBLE AND SINGLE DISCHARGE.—In gold mills where battery amalgamation is practiced the discharge is always single, as one screen will discharge the ore as fast as it is amalgamated. In wet-crushing silver mills, where the ore is hard, it is also usually single, as the battery will discharge from a single screen nearly as fast as the ore

is crushed. At the California mill, although the ore is soft, a single discharge is used; in other places, as, for instance, Silver Reef, Bodie, and Tombstone, a double discharge gives better results than a single one. Comstock men think there is no advantage in a double discharge, as, no matter how soft the ore, the water will carry it out of the battery as soon as crushed. This, however, is doubtful. In Silver Reef, where 10 tons to the stamp are crushed per diem, it is unquestionably advantageous to use a double discharge, and it is extremely doubtful whether power is not always saved and the percentage of slimes diminished by this construction. Local conditions must decide whether the saving effected is counterbalanced by the inconvenience of a double set of sluices and an increased consumption of screens.

For dry-crushing mills a double discharge is necessary, for the ore will not screen nearly so fast as it is crushed. The main point in adjusting a dry battery to crush properly is to make the splash of the pulp as regular and as high as possible, and this is done by dropping the stamps in the proper order, so that the material being crushed shall be evenly distributed in the mortar, and by keeping as little of it as possible under the stamps at one time. Where there are 3 inches or so of ore under the stamps there is no chance for the splash; very little pulp passes through the screens, and the battery is soon choked and fills up.

SCREENS.—There are four kinds of screens in use for quartz-mills: steel and brass wire, and slot and needle-punched sheet-iron. A tin screen is mentioned in the schedule of a gold mill in California, but the advantages are not apparent. For gold mills the punched-slot screen is the one mostly used, though steel wire is sometimes met with; in wet-crushing silver mills steel and brass wire and needle or slot-punched iron are all used. The preference seems to be for the brass wire, though steel is now replacing it. Punched screens are not so much used as formerly. At the California mill they use a horizontal-slot punched screen, which is said to correspond to a No. 50 wire. This may be the case when the screen is new, but after it is slightly worn, as the tank sand shows, it certainly lets through much coarser pulp. These screens are said to work exceedingly well, and are the invention of the superintendent of that mill. In dry-crushing mills the brass and steel wire screens are used.

In gold mills, from No. 5 to 9 slot is the common size; in silver mills, wet- and dry-crushing, from No. 40 to 60 wire screens, though the usual number is 40. At Bodie (wet-crushing) they use as low as No. 20, and at the Manhattan and Eberhardt & Aurora (dry-crushing) they use No. 60. No account of any concave screens is included in the census schedules.

The numbers by which punched screens are known correspond to those of ordinary sewing-needles, from which the punches are made. The width of the slots in slotted screens is equal to the diameter of the holes in a punched screen of the same number. The number of a wire screen is the number of meshes to the linear inch.

SELF-FEEDERS.—The automatic ore feeders employed are the Hendy, Tulloch, Stanford, Victor, and some others, and they seem to be used irrespective of whether the battery is a wet or a dry crusher. The accompanying table shows the number and the character of the self-feeders included in the plant of the mills reported and the extent to which these appliances have been introduced.

TABLE CIX.—PROPORTIONAL NUMBER OF MILLS IN WHICH AUTOMATIC FEEDERS ARE USED.

State or territory.	Number of mills reported.	Number using automatic feed.	Number fed by hand.	Unspecified.
Total	272	115	154	3
Alabama	2	.....	2	.....
Arizona	20	17	3	.....
California	43	26	16	1
Colorado	34	5	29	.....
Dakota	23	11	12	.....
Georgia	26	1	25	.....
Idaho	13	2	11	.....
Maine	1	1	.....	.....
Montana	20	a 6	20	.....
Nevada	44	21	11	2
New Mexico	3	3	.....	.....
North Carolina	5	.....	5	.....
Oregon	6	5	1	.....
Utah	13	7	6	.....
Virginia	5	.....	5	.....
Wyoming	9	.....	9	.....

a Including one mill in which, in addition to automatic machines, feeding by hand is also practiced.

An automatic quicksilver-feeder, for gold mills, acting on the principle of the ore-feeders, is a new feature. It is so connected with the cam shaft that each revolution of a large ratchet wheel, which can be regulated to revolve once in one, two, three, or four minutes, as desired, dips a small cup into a reservoir of quicksilver, and by a trip of its cam empties the contents into a pipe leading to the mortar. The feed is therefore regular and practically continuous.

PLATES.—Gold mills are usually provided with a copper plate, or with a silver-plated copper plate which has been amalgamated with quicksilver, for the purpose of catching the gold or the amalgam as it comes from the battery. This plate is called an apron, and is as wide as the discharge of the battery, being sometimes rectangular and sometimes tapering toward the sluice. Millmen seem to differ in regard to the respective virtues of copper plate and silver-plated copper plates. Some think that the silver plate, after amalgamation, is too "hard" to catch the amalgam; others (and these are the majority) prefer it, and its use is becoming more general. A silvered plate is much more readily amalgamated and kept clean.

BATTERY POWER.—As a rule, the whole mill is run by one engine or wheel. The California mill is an exception, for the battery of 80 stamps is situated a quarter of a mile from the pan mill, to which the pulp flows through a long sluice. The settling tanks are in the pan mill.

ROCK-BREAKERS.—Blake's (or some modification of it, for the patent has lapsed) is the rock-breaker in use in most mills. Some have none at all, the rock either being fine enough for the battery as it comes from the mine or being broken by hand when necessary. In a few mills Chinese are employed to break rock for the batteries. The following table shows the number of mills reported as having rock-breakers, and the number of the latter in use. It will be observed that the proportion is very slightly over one per mill, except in the case of the Dakota mills:

TABLE CX.—NUMBER OF MILLS REPORTED AS HAVING ROCK-BREAKERS, AND NUMBER OF ROCK-BREAKERS IN USE.

State or territory.	Number of mills reported as having rock-breakers.	Number of rock-breakers reported.
Total	126	164
Arizona	13	16
California	13	13
Colorado	13	13
Dakota	11	20
Idaho	11	11
Maine	1	1
Montana	8	8
Nevada	23	34
New Mexico	2	2
North Carolina	1	1
Oregon	2	2
Utah	17	19
Virginia	4	4

DRYING THE ORE.—In dry-crushing mills the ore is generally dried on cast-iron plates set over the flues of the roaster, where there is one; where no roaster is used, the plates are heated by a special fire. The Pacific rotary drier is in use in some mills, and consists of a revolving cylinder, through which the ore passes continuously at the same time that the heated air from a special fireplace passes through the cylinder in the opposite direction. The cylinder is set at a slight angle from the horizontal, and acts somewhat on the principle of the Howell furnace. This rotary drier seems to work very well, and certainly produces a great saving of labor, for in drying the ore by the ordinary method on plates it is necessary to turn it over frequently by hand. This mechanical process of drying, however, fails to utilize the waste heat from the roasting furnace, in case one is employed, which fact renders the rotary drier less profitable than it otherwise would be.

MORTAR CASTINGS.—Mortars are now almost invariably made in one solid casting. The practice of casting them in several pieces, to be bolted together, is justified only when great difficulties in transportation are to be overcome. If the only possible means of conveying machinery to a district difficult of access is by pack-train, the separate portions must not be heavier than from 300 to 350 pounds each. Foundery men, in supplying plant for remote districts, as, for example, Mexico and Central America, have shown great ingenuity in furnishing sectional castings. This plan is available in the case of many items of mining and milling machinery, but for mortars single castings are so much stronger that piecing should, if possible, be avoided. The strain upon a mortar, in case the mortar-bed settles in the least degree irregularly, requires corresponding rigidity in the casting; and the pieced mortars cannot be relied upon with confidence, notwithstanding the care taken to make them as efficient as the circumstances admit. Of some 250 mills from which data on this point were obtained not one had a sectional mortar.

DROP.—The length of the "drop" for dry-crushing batteries is usually from 6 to 8 inches, and in wet-crushing from 6½ to 9 inches. The drop for gold-mill batteries is greater than for silver, as it seems that more splash is required where amalgamation is carried on in the mortar than where it is only necessary to pulverize the rock. The greatest drop noted for silver mills is that of the Martin White battery, at Ward, Nevada, where a 750-pound stamp drops 9 inches ninety times a minute.

ADJUSTMENT OF DROP, SPEED, AND WEIGHT OF STAMPS.—Engineers have not been able to deduce any general law governing the length of drop and the number of drops per minute for a given weight of stamps and ore of a certain texture. The fact that in many batteries the weight of stamp, drop, and speed are not the best for the kind of ore that is to be crushed is admitted. It is, however, much easier to condemn the arrangement of a particular battery working on a given ore than it is to say exactly what drop and what number of drops would do the most work with the least proportionate wear and tear. It is a self-evident proposition that the heavier the battery, the greater its drop and the number of drops, the more ore will be crushed. Of course these have their limits in practice. If a 750-pound stamp, dropping 6 inches one hundred times per minute, crushes a given kind of ore at a certain rate, for a harder ore a heavier stamp would be required, or a greater drop, or more drops per minute, and perhaps all three, in order to crush the same amount of ore in a given time. Taking the wear and tear into account, it would seem that if the stamps be made heavier the drop, as well as the number of drops, should be decreased, in order to keep the wear and tear of a battery down to a minimum. The converse of this would be true of a lighter one.

In practice, however, these factors are governed by other considerations. Suppose a company has 15 tons of ore to be crushed in 24 hours and it is intended to put up a battery of 15 stamps, weighing 700 pounds each, to crush this ore; it would be much more advantageous to build a 10-stamp battery of say 1,000-pound stamps (granting that this battery would crush the given quantity of ore, which it would probably do), for the 10-stamp battery would cost about one-quarter less, and the amount saved in cost of plant would more than compensate for the proportionate difference in wear and tear between the two, even taking it for granted that, in point of fact, the wear and tear of the lighter battery would be less per ton of ore crushed.

It is considered a good rule to put up a heavy battery, no matter what may be the character of the ore to be crushed; to give that battery as great a speed as possible, say 100 drops per minute, and to give the stamps as long a drop as their weight and speed will permit. Of course there are some limits to be placed on weight, speed, etc. Stamps ought not to exceed 1,000 pounds in weight; the speed ought not to be over 110 and length of drop not over 8 inches for wet-crushing silver mills. For dry-crushing mills these figures, with the exception of speed, should be somewhat less. The greatest speed of any battery reported is 108, in the Eberhardt & Aurora mill, in White Pine, Nevada, the stamps weighing 750 pounds, and the battery being a dry-crusher with 8-inch drop. Gold-mill batteries are run at a less speed and with a greater drop, other considerations than mere crushing-power, such as amalgamation, altering the usual rules for wet batteries. The Rising Sun mill, in Placer county, California, for instance, has, with 800-pound stamps, a speed of 65 and a drop of 11 inches—the longest noted.

STEAM STAMPS.—A single steam 2-stamp battery is reported in Arizona. Not much progress has been made in the introduction in the far West of steam or of air-cushions to increase the force of the blow given by the stamp in falling. For the copper ores of the Lake Superior region the steam stamp has been found to be very effective, and it would seem that it should be equally so in the case of very tough gold and silver ores, though no sufficient tests have yet been made to afford a basis for comparison with the ordinary gravity stamps. The whole question is, of course, one of relative economy; if the first cost, wear, and repairs of the steam stamp overbalance its superior crushing capacity, it would not be practicable to adopt it.

THE ORDER IN WHICH THE STAMPS FALL.—The order in which the stamps fall has a great influence upon the crushing power of the battery. Four orders are in general use, namely: 1-4-2-5-3, 1-5-2-4-3, 1-3-5-2-4, and 1-3-5-4-2. Many other orders are used, but they are usually adopted through ignorance of the proper order. Millmen do not agree as to which one of the above-named four orders is the correct one; it is a safe rule to lay down, however, that no one of the five stamps after falling should be followed by either of its neighbors. This is the case with the second and fourth orders mentioned, and although they do not give the pulp a bad motion, the first and third orders are preferable, and of these two the first seems to be the best. This opinion is borne out by the usage in most places, many more batteries dropping in the order 1-4-2-5-3, although 1-5-2-4-3 is the order in the California mill batteries and many others.

There is generally one cam shaft for every ten stamps, the second row of stamps having their cams so set that no two stamps fall at the same instant.

In dry-crushing batteries it is often customary to give the outside stamps ½ inch more drop than the others in order to prevent the pulp from drifting too much to the corners.

ROTATION OF STAMPS.—The rotation of the stamp in rising is governed by the amount of grease upon the cam and the tappet. Where the cam and the tappet are dry, the stamp makes nearly a complete revolution, and where there is much grease it scarcely revolves at all. From one-twelfth to one-eighth of a revolution is about what the stamp ought to revolve in rising, as this will be sufficient to cause the shoes and dies to wear evenly and at the same time permit of the cam and the tappet being well lubricated. The rotation in falling is usually very slight.

MINERALOGICAL CHARACTER OF THE ORE.—The mineralogical character of the ore has considerable influence on the quantity crushed. As a rule, quartz ores are more readily pulverized than limestone, which, though softer, is less brittle, and oxidized or chloride ores easier than sulphurets. The least difficult ore to crush is the Silver Reef sandstone, and the hardest the flinty quartz of some of the Arizona mines.

AVERAGE NUMBER OF TONS CRUSHED.—In wet-crushing the number of tons pulverized varies from 1 to 5 in twenty-four hours, according to the character of the ore, and in dry-crushing from three-quarters of a ton to 2 tons to the stamp. At Silver Reef, however, no less than 10 tons of sandstone per stamp are passed through a wet battery. This rock requires to be disintegrated rather than crushed, the individual particles of quartz composing it being small enough to pass through the screens without further division.

AMALGAM CAUGHT IN THE BATTERY.—The data in the schedules in regard to the amount of amalgam caught in the batteries of gold mills are rather vague. From one-third to two-thirds of the total amount of amalgam saved is caught in the battery, and the usual amount is over one-half. There is ordinarily little silver saved, except that which is alloyed with the gold. Battery amalgamation in silver mills, which was formerly common, is now seldom practiced.

GOLD AND SILVER IN BATTERY AMALGAM.—The gold and silver in the battery amalgam of gold mills form from one-third to one-half of the weight of the amalgam; the more silver the gold contains and the finer it is the more quicksilver does it require for amalgamation. The gold bullion from this mixture is worth from $12 to $18 per ounce, showing that the proportion of silver in the alloy is very small. Scarcely any other metals are found in this bullion with the exception of a little lead or copper. The fact must not be lost sight of that in the amalgamation of gold that metal is not so perfectly alloyed with the quicksilver as is the case with silver, but is merely coated on the outside with a thin film of quicksilver, which causes the separate particles of gold to adhere together, thereby forming a pasty mass which has the appearance of a true amalgam. This is easily perceptible where the gold is coarse, as the particles can be distinctly felt by pressing the amalgam between the fingers. In the amalgamation of gold it is necessary to keep the amalgam at a certain consistency. If there is too much quicksilver, it will flow too easily and not be caught on the amalgamated copper or silver plates; and if there is not enough, the gold is imperfectly amalgamated and is carried off in the tailings.

WEAR AND CONSUMPTION.—Cams last from one year to three years, the length of time depending on many things, but principally upon the care with which the battery is handled. At the California mill, where especial pains is taken to keep account of the wear and tear, experience shows that the usual life of a cam is sixteen months. Cams usually break at the hub, but sometimes the extreme tips break off. It is said that in certain European works where the stamp-battery has been introduced it has been abandoned on account of the rapid wear of cams. Inappropriate handling only can explain such a result.

Other things being equal, the length of time which shoes and dies last depends upon their dimensions. A frequent replacement of those portions of the battery causes a serious interruption of work and a rapid accumulation of old iron, while the battery is less efficient with old shoes and dies than when provided with such as are new or but little worn. The usual practice is to employ shoes and dies which will last one or two months in wet-crushing and from two to four months in dry-crushing.

Shoes wear much faster than dies, because the latter are always covered with a layer of rock or pulp, the impact being between the shoe face and the ore. The exact relation probably depends upon the feeding, a thick layer of ore protecting the die more effectually than a thin one. From a half to two-thirds as much iron is worn from the dies as from the shoes in a given time. In many mills the dimensions of the shoes and dies are so selected that they will wear out in the same time, and this plan certainly seems commendable, since only a simple stoppage is required to reset the battery instead of two. Shoes and dies are commonly used till their weight is diminished to from 25 to 50 pounds. Occasionally, however, they break in the battery, and must then, of course, be removed, however little they may be worn.

The consumption of iron in the battery per ton of ore crushed depends upon a number of points, some of which are as follows: The material employed for the castings chips if too hard and wears rapidly if too soft. Steel generally lasts about three times as long as iron. The character of the ore is perhaps less strikingly influential on the consumption of iron than might have been supposed. The Comstock ores, for example, are usually in a fine state of division as they leave the mine; yet the shoes and dies of the California mill do not wear unusually long. The fact is that comparatively little of the Comstock ore will pass the screens without further division, and the large particles are as hard to crush as any quartz. The Silver Reef ores, as has already been pointed out, are exceptional. The level of the die surface has much to do with the consumption of iron. In the gold mills of California and Colorado, where battery amalgamation is practiced, the freedom of discharge is intentionally diminished by setting the die surface several inches below the lower edge of the screen. The wear of iron is consequently greater in these mills than in wet-crushing silver-stamp batteries. The size of the openings in the screens, and no doubt also their number, has an influence on the wear of the iron corresponding to the work done in reducing the pulp to the necessary fineness. Dry-crushing batteries certainly consume less iron than wet-crushing batteries per ton of ore crushed, probably because in wet batteries the particles of dust are removed from the face of the iron as fast as formed, allowing the die to descend immediately upon the larger fragments. The modifying

conditions are so numerous that accurate data as to the consumption of iron in the batteries cannot be given. The wear per ton of ore crushed in dry batteries, however, sometimes falls a little below one pound per ton, and may average a pound and a quarter, while in wet-crushing over two pounds is not uncommon, and a pound and three-quarters is not far from the mean.

Screens last from five to thirty days in wet-crushing and from seven to forty days in dry. The average for both wet- and dry-crushing mills is about fifteen days where punched screens are used in wet mills and brass wire in dry, for in wet-crushing the punched screen will last one-third longer than the brass-wire screen.

QUICKSILVER USED IN BATTERY.—In battery amalgamation the amount of quicksilver added depends on the quantity of gold in the ore. It is necessary to add quicksilver enough to amalgamate the gold and still keep it in that pasty condition which causes it to adhere to the copper or silver plates. From one to two ounces of quicksilver per ounce of gold in the ore is about the usual quantity used.

WATER USED IN THE BATTERY.—It is generally difficult to ascertain the quantity of water used in batteries, but some trustworthy data show a consumption of from 500 to 700 gallons per ton crushed. According to the circular of Prescott, Scott & Co., of San Francisco, each stamp requires 10 pounds per minute, which, at the rate of 3 tons crushed per stamp in twenty-four hours, would make 576 gallons per ton. Many mills, however, use much more water. Where water is scarce, it is usual to pump it back from the slime tanks or ponds to the battery.

SHAPE OF OLD SHOES AND DIES.—Shoes generally wear slightly concave in the center, the outer rim being rounded or chipped off. Dies usually wear a little convex in the center, gradually becoming somewhat concave toward the outer edge. These depressions commonly vary from half an inch to 1 inch.

METHOD OF HANDLING DRY-CRUSHED ORE.—In almost all dry-crushing mills where the ore is roasted the ore is removed from the screens by means of a screw-conveyor. Where no roasting is done the "pulp" (*a*) is removed in cars, which are placed to catch it as it falls from the battery, and is thus carted to the pans.

GRADE OF SLUICES.—The grade of sluices from the battery to the settling tanks is usually from three-quarters of an inch to 2 inches per foot; 1 inch to the foot is sufficient, except with very heavy ores, and more than 2 inches is probably never necessary. Where higher grades are employed, as they often are for short sluices, it is not because they are necessary, but because the disposition of the apparatus makes it convenient. The California mill at Virginia has a sluice 1,200 feet long with an average grade of five-eighths of an inch. It is probable that a somewhat steeper grade would have been adopted had circumstances permitted, but the fact that so low a grade answers the purposes of a highly-successful mill shows that high grades are indispensable only with very heavy ores. These data apply for the normal quantity of water fed to the batteries. It is worth while to remember, however, that the carrying power of water varies with the sixth power of the velocity, and the velocity varies as the square root of the fall. The transporting power of a current, therefore, varies as the third power of the fall. The slower the current in the settling tanks, too, other things being equal, the more complete the separation of the pulp from the water or the smaller the quantity of slimes leaving the mill. These facts show that a small consumption of water is desirable, and indicate, as the most economical practice, batteries with great discharging capacity fed with as little water as is compatible with efficient discharge, sluices of ample grade, and comparatively few settling tanks.

SETTLING TANKS.—Settling tanks vary in size, but the greater part of them are 6 feet long by 5 feet wide by 38 inches deep. The pulp generally fills them to a depth of about 24 inches, which represents about 3 tons of dry ore. A few tanks are made much larger, the maximum reported being 12 by 15 feet with a depth of 3 feet, and the minimum 4 by 4 feet with a depth of 32 inches.

PROPORTION OF SLIMES.—From 1 to 15 per cent. of the ore passes out of the mill in the form of slimes. Ores carrying clay produce far more slimes than those from which it is absent, and of course fine crushing and insufficient tank capacity increase the amount of ore which fails to settle in the tanks. Slimes from doré ore are usually poorer in silver and richer in gold than the ore itself. The treatment of the slimes, if they are saved in settling ponds, forms the subject of special manipulation; but there are many mills at which no attempt is made to collect and work the slimes.

PAN AMALGAMATION.

PLANT.—The number of pans required in a mill in proportion to the number of stamps is governed by the character of the battery (whether it is wet or dry), the quantity of ore crushed by the battery in a given time, the time required to amalgamate the ore, and the size of the pans to be used. In wet-crushing mills the proportion varies from two pans to every five stamps to two pans for every stamp. This latter is the case at the Leeds mill, at Silver Reef, in Utah. Generally from two to three pans, holding from 3,000 to 4,000 pounds, are required for every five stamps. In dry-crushing two pans to five stamps are always sufficient unless the pans are small or the ore is very easily crushed, and sometimes one large pan can be made to do the amalgamating for five stamps. In mills recently built one settler is allowed for every two pans. In the Star mill, at Cherry Creek, and at the Manhattan, in Austin, there is a settler for each pan. This is probably unnecessary, as roasted pulp is very easily settled.

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a The word "pulp" is used by millmen to designate pulverized ore, whether wet or dry, roasted or raw.

Agitators are in use on the Comstock, at Bodie, and in some other placers, but they are not generally employed. The object in using them is not only to catch the amalgam which may sometimes escape the settler, but to save the coarse sand or concentrations which have been but imperfectly worked in the pans. The agitator is also a convenient receptacle for sweepings and metalliferous refuse. Where agitators are used the proportion is one agitator to every five or six settlers.

A clean-up pan is always needed in a mill, for in it the amalgam from scraping the pans, mullers, and old castings can be separated from the pulp and sand with which it is mixed. It is also very convenient for cleaning quicksilver.

But few mills have pans used especially for working tailings.

Hydraulic strainers are not often found away from the Comstock. They are a great saving in handling large quantities of amalgam.

Usually one retort and one melting furnace are sufficient for a 10-stamp mill.

For raising the quicksilver from the settler to the pan floor pumps, cup elevators, and hydraulic elevators are in use in the larger and better mills. In small and old-fashioned mills the quicksilver is returned to the higher level in buckets by hand; but the hydraulic elevator is superseding all others, because from the simplicity of its construction it is not liable to get out of order. It consists of a strong reservoir, into which, the quicksilver having been admitted, a column of water is turned on, forcing the quicksilver through a pipe to the floor above. If water pressure is not to be had, steam from the boiler, usually supplied at about 90 pounds pressure, will answer the same purpose.

The following tables show the more important apparatus of 128 amalgamating mills in which the pan process is in use. The greater number are silver mills, but some gold mills which have pans, settlers, etc., are included:

TABLE CXI.—AMALGAMATING PLANT OF LEADING MILLS.

County and district.	Number of mills reported.	Number of ore pans.	Number of settlers.	Number of agitators.	Number of clean-up pans.	Number of tailings pans.	Number of hydraulic strainers.	Number of quicksilver pumps.	Number of retorts.	Number of melting furnaces.
ARIZONA.										
MARICOPA.										
Globe	2	6	3	.....	2	.....	.....	.....	2	2
MOHAVE.										
Cedar Valley	1	2	1	.....	1	.....	.....	.....	1	1
Hualapai	1	22	1	.....	1	.....	.....	.....	1	1
Owens	1	6	3	.....	1	.....	.....	.....	1	1
PIMA.										
Arivaca	2	4	2	.....	1	.....	.....	.....	1	1
Tombstone	8	34	12	1	8	.....	.....	2	6	4
PINAL.										
Globe	1	2	1	.....	1	.....	.....	.....	1	1
Pioneer	1	3	1	.....	1	.....	.....	.....	1	1
YAVAPAI.										
Peck	1	4	2	.....	1	.....	.....	.....	2	1
Pine Grove	1	3	1	.....	.....	.....	.....	.....	1	1
Tiger	1	4	2	.....	1	.....	.....	.....	2	2
.....	1	4	2	.....	1	.....	.....	.....	3	3
CALIFORNIA.										
MARIPOSA.										
Mariposa Estate	1	4	2	.....	1	4	.....	4	1	1
MONO.										
Bluid Spring	1	1	1	.....	.....	.....	.....	.....	1	1
Bodie	8	84	43	9	8	.....	.....	7	11	8
SAN BERNARDINO.										
Clark	2	6	2	.....	1	.....	.....	.....	2	2
SHASTA.										
Pittsburgh	1	4	2	1	.....	.....	.....	.....	1	1
SISKIYOU.										
Sawyer's Bar	1	(a)	.....	.....	.....	.....	.....	.....	1	1
South fork Salmon	1	.....	1	.....	(b)	1	.....	.....	1	1

a Two barrels.

b One barrel.

TABLE CXI.—AMALGAMATING PLANT OF LEADING MILLS—Continued.

COLORADO.

County and district.	Number of mills reported.	Number of ore pans.	Number of settlers.	Number of agitators.	Number of clean-up pans.	Number of tailings pans.	Number of hydraulic strainers.	Number of quicksilver pumps.	Number of retorts.	Number of melting furnaces.
BOULDER.										
Grand Island	1	9	5	.....	1	.....	.....	.....	2	2
CLEAR CREEK.										
Griffith	1	4	2	.....	1	.....	.....	.....	2	1
CUSTER.										
Hardscrabble	1	8	4	2	.....	.....	.....	.....	1	1
DAKOTA.										
LAWRENCE.										
Bear Butte	1	4	2	1	1	.....	.....	.....	1	1
Whitewood	1	4	2	.....	1	.....	.....	.....	1	1
GEORGIA.										
LUMPKIN.										
Twelfth	1	6	.....	.....	.....	.....	.....	.....	2	.....
IDAHO.										
ALTURAS.										
Bonaparte	1	12	a7	.....	1	.....	.....	.....	1	.....
Middle Boisé	5	22	13	1	3	.....	.....	.....	3	2
Rocky Bar, or Bear Creek	1	.....	1	.....	.....	.....	.....	.....	.....	.....
BOISÉ.										
Banner	1	4	3	.....	1	.....	.....	.....	1	1
Elkhorn	1	1	.....	.....	.....	.....	.....	.....	.....	.....
Granite	1	4	2	.....	.....	.....	.....	.....	.....	.....
LEMHI.										
Yankee Fork	2	9	5	.....	1	.....	.....	.....	4	1
OWYHEE.										
Carson	7	51	26	7	6	.....	.....	.....	11	5
Wagontown	1	4	3	1	1	.....	.....	.....	1	.....
MAINE.										
HANCOCK.										
Sullivan	1	2	1	.....	1	.....	.....	.....	1	1
MONTANA.										
BEAVER HEAD.										
Bald Mountain	1	2	1	.....	.....	.....	2	.....	1	1
DEER LODGE.										
Flint Creek	2	12	6	3	2	.....	.....	.....	3	4
Summit Valley	8	36	18	.....	6	.....	4	.....	11	10
JEFFERSON.										
Elkhorn	1	3	1	.....	1	.....	.....	.....	1	1
LEWIS AND CLARKE.										
Stemple	1	2	1	.....	.....	.....	.....	.....	1	.....
NEVADA.										
ELKO.										
Columbia	1	4	2	.....	1	.....	.....	.....	2	1
Tuscarora	3	22	11	.....	3	.....	.....	2	7	4
ESMERALDA.										
Black Mountain	1	2	1	.....	.....	.....	.....	.....	2	1
Columbus	2	22	11	.....	2	.....	1	2	7	3
Esmeralda	1	4	.....	.....	1	.....	.....	.....	2	1
Oneota	1	2	1	.....	1	.....	.....	.....	1	1
Pine Grove	1	2	1	3	.....	.....	.....	.....	.....	.....

a Including 1 clean-up settler.

TABLE CXI.—AMALGAMATING PLANT OF LEADING MILLS—Continued.

NEVADA—Continued.

County and district.	Number of mills reported.	Number of ore pans.	Number of settlers.	Number of agitators.	Number of clean-up pans.	Number of tailings pans.	Number of hydraulic strainers.	Number of quicksilver pumps.	Number of retorts.	Number of melting furnaces.
EUREKA.										
Cortes	1	8	1	.....	1	.....	.....	.....	1	2
HUMBOLDT.										
Mount Rose	2	9	4	.....	2	.....	.....	.....	3	2
Winnemucca	1	4	2	.....	.....	.....	.....	.....	2	1
LANDER.										
Lewis	1	3	2	.....	1	.....	.....	.....	1	1
Reese River	1	8	8	.....	1	.....	.....	1	3	2
LINCOLN.										
Eldorado	1	2	1	.....	.....	.....	.....	.....	1	1
Ely	1	14	7	.....	1	.....	.....	1	6	4
Pahranagat	1	8	4	.....	1	.....	.....	.....	1	1
NYE.										
Morey	1	4	3	1	1	.....	.....	.....	1	1
Tybo	1	10	5	.....	1	.....	.....	.....	2	2
Union	1	12	6	.....	1	.....	.....	1	2	2
STOREY, LYON, AND ORMSBY.										
The Comstock	17	210	a 139	31	26	b 73	c 2	2	52	d 3
WHITE PINE.										
Cherry Creek	1	8	8	.....	1	.....	.....	1	2	2
Ward	1	10	5	.....	1	.....	.....	1	3	2
White Pine	1	16	8	4	2	.....	.....	.....	4	3
NEW MEXICO.										
DOÑA AÑA.										
Hillsborough	1	1	1	1	4	.....	.....	.....	1	.....
GRANT.										
Silver Flat	2	12	6	1	2	2	.....	.....	2	2
NORTH CAROLINA.										
MECKLENBURG.										
.....	1	2	1	.....	.....	.....	(e)	.....	1	1
OREGON.										
GRANT.										
Granite	1	4	2	.....	1	.....	.....	1	2	1
UTAH.										
BEAVER.										
Milford	1	6	3	.....	.....	.....	.....	.....	1	.....
JUAB.										
Tintic	2	11	6	.....	1	.....	.....	.....	2	2
SUMMIT.										
Uintah	1	24	12	1	2	.....	.....	1	4	2
TOOELE.										
Camp Floyd	1	8	4	.....	1	.....	.....	.....	2	2
Rush Valley	1	2	1	.....	.....	.....	.....	.....	1	.....
UTAH.										
Tintic	1	4	2	.....	1	.....	.....	.....	1	1
WASHINGTON.										
Harrisburgh, or Silver Reef	4	35	18	.....	.....	.....	.....	.....	9	8
VIRGINIA.										
CULPEPER.										
.....	1	5	1	.....	.....	.....	.....	.....	1	1

a Including tailings and slime settlers.
b Including slime pans.
c California mill only.
d Not including melting furnaces in assay offices.
e One steam strainer.

TABLE CXII.—PAN AMALGAMATION PLANT: RECAPITULATION BY STATES AND TERRITORIES.

State or territory.	Number of mills reported.	Number of ore pans.	Number of settlers.	Number of agitators.	Number of clean-up pans.	Number of tailings pans.	Number of hydraulic strainers.	Number of quicksilver pumps.	Number of retorts.	Number of melting furnaces.
Total	128	853	472	68	111	80	9	26	221	127
Arizona	16	62	31	1	14	.....	.....	2	22	19
California	13	99	51	10	10	5	.....	11	10	15
Colorado	3	21	11	2	2	.....	.....	.....	5	4
Dakota	2	8	4	1	2	.....	.....	.....	2	2
Georgia	1	6	.....	.....	.....	.....	.....	.....	2	.....
Idaho	20	107	60	9	13	.....	.....	.....	21	9
Maine	1	2	1	.....	1	.....	.....	.....	1	1
Montana	13	55	27	3	9	.....	6	.....	17	16
Nevada	42	379	220	30	46	73	2	11	105	41
New Mexico	3	13	7	2	6	2	.....	.....	3	2
North Carolina	1	2	1	.....	.....	.....	.....	.....	1	1
Oregon	1	4	2	.....	1	.....	.....	1	2	1
Utah	11	90	46	1	5	.....	.....	1	20	15
Virginia	1	5	1	.....	.....	.....	.....	.....	1	1

PANS FOR WORKING ORE.—The pans used in amalgamation have a capacity of from 1,500 to 4,000 pounds and are of various construction. One only of them will be described, (*a*) the "combination", which, with its various modifications, is the one most employed in silver mills. When this pan is used for working free ore the sides and bottom (the latter perfectly flat) are cast in one piece. The sides flare slightly upward, the top being an inch or two larger in diameter than the bottom. A cast-iron cover is made to fit the top closely, and in this there is a hole, with a cover, through which the charge is introduced. The bottom of the pan is either provided with slots to receive the lugs of the dies, or with a false bottom of cast iron about an inch thick, provided with openings for the lugs which hold the dies in place. The bottom of the muller is flat, and also contains slots, in which the lugs of the shoes are fixed. There are three wings or flanges placed at the top of the pan at equal distances on the circumference. When the muller is in motion the pulp is thrown to the outside of the pan, and, rising to the top, strikes against the wings, by which it is projected to the center, where it again falls to the bottom. In this way a complete circulation is obtained, the pulp not only flowing around the pan, but receiving a motion from the outside to the inside and downward, and from the inside to the outside and upward, thereby inducing an intimate mixture between the pulp and the quicksilver. When it is necessary to grind the pulp the muller is lowered by means of a screw in the top of the sleeve until the bottoms of the shoes just touch the tops of the dies. Some of the other pans in use also give a fair motion to the pulp, but for convenience in handling and quality of work the combination pan up to the present time has best fulfilled the conditions for the amalgamation of silver ores.

Where this pan is used for working roasted ores its construction is somewhat different. The bottom is of cast iron, wooden staves are used for the sides, and the cover is made of wood. The die, instead of being in several pieces, is cast whole, completely filling the bottom of the pan; the shoes and muller are one casting, and as little metal is exposed as the necessary construction of the pan will permit. This is for the purpose of reducing as much as possible the action upon the iron of the acids and acid salts frequently present to a greater or less extent in roasted pulp. Pans for working raw ore are also sometimes made with wooden sides, this under certain conditions being a cheaper construction. In the combination pan the number of the shoes is from six to twelve, and they weigh from 500 to 800 pounds, and are from 2 to 3 inches thick. The dies are similar in number, weight, and thickness. In some mills, as at Austin, when the shoes are worn off the mullers they are replaced by wooden ones, which answer the same purpose as the iron, the object being to give motion to the pulp and not to grind.

As a novelty, it may be mentioned that in a certain mill in Arizona glass shoes and dies and a wooden muller are used. The muller has copper and iron plates fastened to it (said to be for the purpose of furnishing electricity), but the whole affair is reported to be a failure, and is cited merely to show what extraordinary pans are sometimes constructed.

METHOD OF HEATING PANS.—The usual method of heating pans is by injecting live steam directly into the pulp by means of an iron pipe which descends near the outside of the pan to within 6 or 8 inches of the bottom. This method is unquestionably the best, but it has its disadvantages, of which the diluting of the pulp and continual wearing away of the pipe are the greatest. This latter is particularly the case with roasted ores. In Virginia City, where the pulp is run thin, the slight dilution caused by steam is of little importance; but in places where it is necessary to keep the pulp thick it is inconvenient. It is less objectionable in working free than in working roasted ores, for there are many kinds of the latter which, although they may be charged into the pan so thick that

a For a history of the Washoe pan and its varieties, see *Exploration of the Fortieth Parallel*, vol. iii, Mining Industry, by J. D. Hague.

they check the motion of the muller, yet, in the course of half an hour or so, the different salts having dissolved, become so thin that, with the consequent rapid circulation, they slop over, and this without the addition of steam. The effect of running roasted ore as a thin pulp is to a great extent counteracted by the fact that roasted ore, being easy of amalgamation, does not require the quicksilver to be so finely divided and so intimately mixed with it as is the case with raw ores.

Another method of heating is by means of a steam-chest under the pan, and more rarely by means of a jacket, in which exhaust steam may be used. It is only with the freest ores that it is safe to heat pans in this way, and even with such ores the pans frequently leak into the steam-chest. The reason for this is plain; the action between the salts (whether in the shape of chemicals added to the ore or formed in roasting) and the iron of the pan will be strongest at the hottest point, namely, the bottom of the pan, and should there be a defective spot in the casting a hole would soon be eaten through. In Bodie this method is in use, but the conditions are favorable, as the ores are free.

NUMBER OF REVOLUTIONS OF PANS PER MINUTE.—Pan mullers generally make from sixty to ninety revolutions per minute. It is true that the faster the muller is run the more work is done in a given time, but questions of wear and tear of machinery have thus far usually limited the speed to ninety revolutions. The pans at the California mill are geared to run ninety-five revolutions.

WEIGHT OF CHARGE.—A pan charge weighs from 1,500 to 4,000 pounds, according to the size of the pans. A 4,000-pound pan is 5 feet 6 inches in diameter and 30 inches deep. In working rich ore the charges are generally smaller than in working low-grade pulp.

TEMPERATURE.—The temperature maintained in the pan has much influence upon the amalgamation of the ore. The effect of temperature on the amalgamation of the base metals, lead and copper, is not very well understood, and it can only be determined by careful and exhaustive experiments. It seems to be a well-established fact that in the amalgamation of chloride ores which carry a considerable percentage of carbonate of lead a fine bullion may be obtained without an appreciable loss of silver by keeping the temperature of the charge considerably below the boiling point (say at 120° F.). At exactly what temperature it will be necessary to keep a given kind of pulp experiment alone can show. Time, as before mentioned, has also an influence on the results. The reason for the earlier amalgamation of the silver at a temperature of 100° F. or thereabout seems to be that the conversion of the carbonate into the chloride of lead (the form in which it is necessary for the lead to be in order to be precipitated by the iron and amalgamated by the quicksilver) takes place much less readily at a temperature of 100° F. than it does at 200° F. Were the conditions entirely uniform, the metals would be amalgamated in the order of their electro-negative properties; that is to say, first silver, then copper, and last lead; but in practice this is not the case, as unquestionably lead is amalgamated at the same time as the silver. The reason is that the pan and the pulp do not furnish all the conditions of a true galvanic cell. For instance, it is possible to conceive of a particle of carbonate of lead, not in conjunction with a particle of chloride of silver, coming into contact with the iron of the pan in the solution of salt or salt and bluestone, as the case may be. Under such circumstances the particle of carbonate would be converted into chloride and metallic lead would be precipitated and amalgamated.

It is customary to keep roasted ore at a temperature of 200° F. At the California mill the pans are heated to 150° F.

TIME OF WORKING A CHARGE.—The time occupied for working a charge is from five to eight hours. It is largely governed by the value of the ore. With any given ore, experience shows how far it is profitable to prolong the amalgamating process, which proceeds more and more slowly as the silver is taken up. In many cases, where a comparatively small portion of the silver is extracted by pan amalgamation, this is not due to the imperfection of the process, but to the fact that, under the local economic conditions, it is not profitable to continue the process until a large percentage is saved.

CONTINUOUS AMALGAMATION.—A system of handling ore in wet-crushing mills, known as the "Boss" process, has been introduced at Bodie, which dispenses with the laborious work of shoveling the pulp from the settling tanks. The ore is, as usual, crushed in a battery, but with as little water as possible, and the pulp is thence conducted to the first of a series of pans in which the mullers are revolving. From this pan it flows to the next, and so on through the series, until from the last pan it passes through a series of settlers, and finally from the last settler out of the mill. The pans are heated by steam in false bottoms, so that the pulp is not thinned. It becomes thicker as it progresses. The chemicals are added in the first pan, and the quicksilver is added at a stage when the pulp is thick enough to hold it.

GRINDING.—When ores are submitted to chloridizing-roasting, grinding is scarcely necessary, because the silver chloride passes into solution, and to some extent this is also true of raw chloride ores; but with all other ores a finer comminution than can be attained in the battery is probably essential to effectual amalgamation. As a rule, the muller is kept down about half the time necessary to work the charge. During this period chemicals, such as bluestone and salt, if added, are supposed to have produced their full effect, and at the close of it the quicksilver is added. After the addition of the quicksilver the shoes are usually raised from the dies, to avoid the flouring of the quicksilver by excessive mechanical division in the presence of more or less adherent substances. At the California mill, it is true, grinding is continued throughout the entire treatment in the pans, and it is said

with satisfactory results. This practice seems to carry great authority, because the usual method was formerly pursued under the same management. Possibly, however, the charge of the pans at this mill contains less adherent material than is ordinarily the case; it is certainly less base. Grinding, after the addition of quicksilver, is especially objectionable if lead is present.

It is asserted by some millmen of experience that grinding is unnecessary with silver ores unless they contain a large proportion of gold, and there is no doubt that finer bullion is obtained when the ore is not ground; but gold is more readily amalgamated than silver, and if grinding is desirable where gold is present it is difficult to avoid the conclusion that it is still more essential when the ore is purely argentiferous. Thus 76 per cent. of the assay value of the gold contained in about 300,000 tons of Hale & Norcross ore during the eight years ending January 31, 1874, was saved by amalgamation, while only 61 per cent. of the silver in the same ore was extracted. As is the case with almost all technical operations, local economic conditions determine the extent to which grinding is profitable; but experiments to decide such points are too often omitted, or conducted under the bias of preconceived opinions.

QUANTITY OF QUICKSILVER ADDED.—To effect a separation between the pulp and the amalgam it is essential that a certain volume of quicksilver should be added in the pans, for otherwise the amalgam would not gather at the bottom of the settler. Not less than 100 pounds of quicksilver to the ton of ore appears to be sufficient for this purpose; and for the ordinary pan, constructed to treat 2 tons of ore at a time, the minimum charge of quicksilver is consequently, as a rule, 200 pounds, and this only when the ore is free and of low grade. When the ore is rich, a further addition of quicksilver is made. The proportion of quicksilver to silver in the fluid amalgam should never be less than a pound to the ounce, however rich the ore may be. In working free ore the quicksilver is added from two to four hours after charging, but with roasted ores it has become the custom to add the quicksilver at once upon charging; and experience has shown that when this plan is adopted amalgamation is more complete, while the loss of quicksilver is not increased.

CHEMICALS USED IN AMALGAMATION.—The list of chemicals used in the amalgamation of silver ores is growing smaller year by year. At present, except in a few isolated cases, the only chemicals employed in working ores raw are salt and bluestone. The reactions which take place in pan amalgamation have been but little studied; indeed, chemists have not yet reached definite conclusions as to the essential reactions of the patio process, a subject to which a number of elaborate investigations have been devoted. There seems little question that the use of bluestone and salt accelerates the reduction of argentite. The sulpho-salts of silver are also attacked, but are either only partially decomposed or so slowly reduced that it is not as cheap to treat them raw with chemicals as to submit them to a preliminary chloridizing-roasting.

There is no exact rule in use governing the quantity of bluestone and salt added, though larger quantities of chemicals are usually employed in working high-grade ores than in treating poor ones. The baser the ore the more bluestone and salt are commonly considered requisite, but the quantity of each can only be increased to that amount which will result in a yield of silver corresponding to the cost of the extra weight of bluestone and salt employed. There can be no doubt that much money has been wasted in the unnecessary and ineffective use of chemicals. The proportion which salt ought to bear to bluestone is another point, which, although of the greatest importance economically, is not well understood. Most millmen use more salt than bluestone, but others more bluestone than salt. On the Comstock, where experiments have been conducted for many years, the proper quantity of bluestone and salt, and the proportion of the one to the other to be used with any grade of the ore of that district, has been ascertained approximately; but Comstock rules would not apply in general to other ores, though doubtless there are many of substantially the same character. At the California mill, with $30 ore, 2 pounds of sulphate of copper and 6 pounds of salt are used per charge of 2 tons; with $80 ore, from 10 to 12 pounds of bluestone and 20 pounds of salt. The chemicals are added on charging. Modifications in the Comstock practice depend on the baseness of the amalgam, the tailings assays, and the appearance of the quicksilver.

As a curiosity the following list of chemicals which are used in a mill in Arizona may be mentioned: One and a half hours after charging, 20 pounds of salt, 3 ounces of cyanide of potassium, 2 ounces of sulphuric acid, 1 ounce of nitric acid, 1 ounce of hydrochloric acid, and ¼ pound of carbonate of lime. The superintendent does not profess to know what reactions are produced. In some of the mills at Bodie hydrochloric acid and carbonate of soda are used. This is equivalent to an addition of salt. In districts such as White Pine, where silver occurs almost entirely in the form of chloride, little or no bluestone is required.

When grease has got into the pans caustic potash, soda, ashes, or cyanide of potassium is added. The latter is also used upon the quicksilver in the tubs to keep it clean. Caustic lime is sometimes used with roasted ores containing a great deal of cupric chloride. It forms chloride of lime, reducing the cupric to cuprous chloride.

Sodium amalgam is found to be useful in amalgamating ores which contain the binoxide of manganese, as it prevents the flouring of the quicksilver which that mineral occasions.

Two noteworthy cases of a waste of chemicals are reported, in one instance the use of copperas in pans with roasted ore, and in another the use of bluestone with roasted ore, which already contained dichloride of copper.

Chemicals are added on charging, with the exception of caustic potash, soda, etc., which should be added with the quicksilver, which they are designed to keep bright.

At Dayton, where large amounts of the Comstock tailings are saved and worked, it is customary to add sulphate of copper in acid solution in large quantities, sometimes as much as the equivalent of 30 pounds of bluestone, when it is found that the loss of quicksilver exceeds the usual quantity. The Comstock tailings contain a very large proportion of clay, and the loss of quicksilver is probably in great part a mechanical one. The clay is said to "ball up" and carry off globules of quicksilver. The acid sulphate probably acts on the clay very much as alum does, promoting its precipitation.

USE OF IRON IN THE PANS.—Iron is one of the important factors in the amalgamation of silver ore. It is used in various forms; in the first place as cast iron in the material of the pans. As wrought iron, in the form of rings, it is sometimes put in the pans, and it is occasionally added to the charge in the form of shavings, filings, etc.

In working free ore much less iron is required than in working roasted ore, and the ordinary wear of the battery and the pan is generally sufficient. One pound of iron will precipitate 3.85 pounds of metallic silver from the chloride, but in practice more than that amount of iron is consumed where there is copper either naturally present in the pulp or added in the form of bluestone. Carbonate of lead is also believed to increase the consumption of iron.

With roasted ore much more iron is required; and where there is a great deal of lead and copper present sometimes as much as 20 pounds of iron to the ton is consumed, not including the iron needed to precipitate the silver. The best form in which to use iron in the pans is as wrought-iron filings sifted as fine as possible, but such filings are expensive and difficult to obtain. The turnings from a lathe are the best substitute. These wrought-iron fragments protect the cast iron of the pan to a great extent from the corrosive action of the different salts in the roasted pulp, as they are more readily dissolved, thus relieving the pan itself from a large amount of loss.

At the Manhattan mill, in Austin, 10 pounds of iron turnings are used to the charge, and they are almost completely consumed. Four pounds of this iron would be sufficient to precipitate the silver; the other portion, as well as the iron from the pans, is probably employed in decomposing lead and copper salts.

LOSS OF QUICKSILVER.—The usual loss of quicksilver runs from half a pound to 3 pounds to the ton of ore treated. A reasonable limit of loss in present practice is 1½ pounds per ton. The waste is in part owing to the difficulty of completely separating the quicksilver from the sand in the settler, and this is particularly the case with ores which contain carbonate of lead or other heavy minerals. To counteract this mechanical difficulty agitators are sometimes used; riffles and blankets in the sluice-boxes from the settlers are also occasionally employed. In ordinary cases sufficient separation can be effected in the settler by the proper arrangement of the shoes on the muller and the regulation of the speed of rotation, but a certain amount of quicksilver is no doubt always carried off in minute globules.

A second cause of the loss of quicksilver is the formation of lead and copper amalgams in the treatment of ores containing these metals or in working silver ores with bluestone. These alloys are pasty substances, which are rapidly reduced to the finest powder by grinding; in other words, the quicksilver is floured, and the separation in the settler is very imperfect. The most radical cure for this condition of the quicksilver is the addition of sodium amalgam in the pans before the ore is drawn off. Sometimes the loss is not sufficient to warrant the use of this expensive alloy, and in such cases it is better to gather the quicksilver and amalgam together, as well as may be, by prolonged treatment in the settler.

In the patio process of amalgamation a very large amount of quicksilver is converted into calomel and lost. In the pan process it is highly probable that one or both chlorides of mercury form to some extent, but these compounds are, for the most part, reduced by the iron. Were this not the case, the loss of quicksilver would be far greater than that actually sustained.

The loss of quicksilver is slightly greater in cold than in warm weather, especially in gold mills. As it is a well-established fact that the process of amalgamation is facilitated by a high temperature it is not strange that cold should interfere with or retard it.

LOSS OF IRON IN THE PANS.—It is a very difficult matter to estimate the amount of iron consumed in the pans in working a given kind of ore. The aggregate amount of iron worn from shoes and dies, shavings, etc., can be easily determined, but it is difficult to estimate the loss from the walls of the pan itself and from the muller. Where free ore is ground the iron worn from shoes and dies is from 6 to 10 pounds to the ton. This iron is more than sufficient to fill the chemical requirements of amalgamation, and it is therefore probable that in such cases the iron of the pan and that of the muller are very little acted upon. With roasted ore, however, this is different, and, as it is not usual to grind it, a good part of the corrosive action comes upon the pan and the muller unless iron is added to the pulp in some form or other. This loss of iron can be estimated at from one-fifth of a pound where the ore is free, poor, and not ground, up to 25 pounds to the ton where the ore is base, rich, and roasted. At the Martin White mill, at Ward, Nevada, the loss used to be 20 pounds. When free ores are ground in the pan a considerable quantity of finely divided metallic iron separates from the amalgam in the clean-up pan.

EXPLOSIVE GAS IN PANS.—Explosive gas in the pans has only been reported as met with on the Comstock, and under the following circumstances: When the mill is shut down, and the pulp is allowed to remain standing in the covered pans, an explosive gas of some kind is formed, which ignites when a lighted candle is brought near the charging hole. Before this fact was well known several accidents happened which might have ended seriously.

A man standing on the pan-cover of a pan in the California mill brought his candle near the charging-hole to see if the muller was moving, as he had just put on the tightener; the gas becoming ignited, he was blown, together with the cover, into a settler. That explosive gas has been noticed only at Washoe may be due to the fact that the pan-covers fit much more closely there than is usual elsewhere, thus obstructing diffusion. It is difficult to understand how any explosive gas can form in the pans of the California mill. Neither free acid nor sodium amalgam is there employed as a chemical, and the liberation of free hydrogen or hydrogen sulphide is therefore improbable. Mr. H. C. Hahn (*a*) asserts that the amalgamation process is accompanied by the evolution of hydrocarbons, but this is difficult to comprehend in the absence of free acids. In short, the matter requires further investigation.

CLEAN-UP OF MILL AND PANS.—In most mills which run regularly there is a general clean-up at the end of each month. A very considerable quantity of hard amalgam adheres to the shoes and dies and fills the interstices of pans and settlers, which is removed when new shoes and dies are put in place. In custom mills a clean-up is sometimes made when each lot of ore has been worked off, if the lots are of considerable value.

SETTLERS.—The usual size for settlers is a diameter of 8 feet and a depth of 3 feet. Occasionally they are found 9 feet in diameter, and 10 foot settlers are reported in two mills. For ordinary work a diameter of 8 feet is sufficient. At the Manhattan mill, where a settler is used with each pan, the settlers are 6 feet in diameter.

There are two different kinds of mullers used in settlers. In the mills on the Comstock and some others the "spider" muller is common. This consists of four arms projecting horizontally from the center of the muller, and upon each one of these arms a shoe, either of wood or iron, is fastened, which serves to plow up and keep in motion the sand at the bottom of the settler. The other form of muller ends downward in a round disc of iron, which fills the bottom of the settler to within 3 inches or so of its circumference, upon the under side of which long wooden shoes, 3 inches thick, radiating to the outside, are fastened. A settler thus arranged is the best for base ores, as it permits the rubbing and assimilation of the floured particles of amalgam in the bottom of the settler. The muller usually revolves from twelve to fifteen times per minute, although it is sometimes geared to make as many as eighteen revolutions; this, however, is only where very heavy ore is worked, or where the ore has been crushed through a very coarse screen. Such a speed is always attended with more than the usual loss of quicksilver; the greater the diameter of the settler the less ought to be the number of revolutions of its muller. It is customary to keep a charge in the settler until it is nearly time to discharge a pan into it; that is to say, from two to four hours. It is a much easier matter to settle chloridized pulp than that which has not been roasted, for in the process of roasting the particles of quartz, etc., become porous and friable. They are consequently ground finer, and can be retained in suspension in the water with much less motion of the muller.

It requires from fifteen minutes to half an hour to discharge a settler through the series of holes provided for that purpose. The top plug is of course the first to be drawn, in order that the quicksilver may have as long as possible to settle and to avoid the production of rapid currents, which might carry off amalgam. A more rapid discharge would defeat these objects.

STRAINING SACKS.—Canvas is the material usually employed for straining sacks, though in some of the mills at Bodie and other places canton flannel is used for that purpose.

CLEAN-UP PANS.—In many mills it is customary to pass the amalgam from the strainers through a clean-up pan, as in addition to sulphurets iron from the shoes and the dies of the pan is mechanically mixed with it, and it is found more economical to extract these substances before the amalgam is retorted. This process could be introduced to advantage in most mills where it is not now in vogue. A common size for clean-up pans is 5 feet diameter and a depth of 16 inches. They are usually of the Knox pattern.

HOT STRAINING.—As before stated, the base metals which enter into silver amalgam are chiefly lead and copper. For many years attempts have been made to discover a process by which these metals could be eliminated from the amalgam before retorting. Where there are copper and lead minerals in the ore it seems impossible to prevent the presence of the metals in the amalgam. A process of hot straining, now almost entirely abandoned, was for some time in use for the separation of lead amalgam. By it two classes of bullion were obtained, one consisting of tolerably pure silver, and the other of lead, with perhaps 10 per cent. of silver. The copper, however, was retained in the silver amalgam, and partly from mechanical and partly from chemical causes the loss of quicksilver was considerable. But the greatest objection to the process was the ruinous effect that it had upon the health of the men. Quicksilver, perceptibly volatile at a temperature of 40° F., becomes much more so at 212° F, and to keep large quantities exposed to that temperature, where men can inhale its vapor, is extremely objectionable. A process by which lead and copper can be eliminated from the amalgam is much needed. None is known to be in use at present which satisfies the requirements.

In very cold weather a gentle heat is sometimes applied to the amalgam before straining. At the California mill it is customary to keep the straining water at a temperature of 100° F. This facilitates straining, and no evil effects on the health of the men have been noticed.

HYDRAULIC STRAINERS.—These at present are very infrequently used, but they effect a great saving of fuel in retorting. Ordinarily dry silver amalgam from the strainers, where it is free from base metals, has about seven

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a Berg- und hüttenmännische Zeitung, 1870, p. 65.

parts of quicksilver to one part of bullion. When this amalgam is strained under pressure the quicksilver can easily be reduced to three and one-half parts. A pressure of from 100 to 125 pounds to the square inch is used for these strainers.

RETORTING.—The size of the ordinary retort in use is 12 inches in diameter and 4 feet in length inside. It will hold from 600 to 1,000 pounds, according to the quality of amalgam and whether the vent is in the center or at the upper edge of the end. It is usual now to cast retorts with the vent at the upper edge of the end, and if two vents are made opposite each other in the end the retort can be turned over. This kind of retort is fast superseding the old style, where the vent was in the center of the end. Retorts up to 20 inches in diameter are reported. The retorts at the California mill are 5 feet 6 inches long and 14 inches in diameter; the charge is 1,800 pounds. Retorts are sometimes turned either a half or a quarter revolution after a "belly" has formed on the bottom, but generally they do not last long after turning, and the practice is open to strong objections. The retorts are circular in section. Amalgam is not often charged in cups, but is frequently divided by discs of iron, in order to save the trouble of breaking up the bullion for the melting pot. The retorting of a charge occupies from five to nine hours, according to its size and character. From one-sixth to one-half a cord of wood is consumed per 1,000 pounds of amalgam retorted.

The charge is heated slowly to the boiling point of quicksilver and maintained at that temperature until most of the quicksilver has been expelled, when it is gradually heated to a light cherry red for an hour or so, to expel the remainder. A mixture of salt and ashes is used to swab out the retort and for luting on the head. When the retorting is properly done the loss of quicksilver by distillation is merely nominal. At the California mill about one-half a pound of quicksilver is lost per 1,000 pounds of amalgam retorted. Where the vent is at the upper edge, or the amalgam is not base, or the pipe is kept open by a rod, the vent does not choke. With dirty or base amalgam there is always danger that the vent may choke if it is in the center of the end of the retort.

An ordinary retort will stand from 100 to 300 charges if properly handled, but in practice the life of retorts is usually much shorter. Steel retorts have been tried, but it was found that they warped too much. The fact that steel burns out sooner than cast iron would be a sufficient objection to its use.

In some small gold mills, where the amount of bullion produced is not large, simple bulb retorts of cast iron are used in place of the cylindrical ones. The bulb retorts require no brick fitting, and can be used over an assay furnace or a blacksmith's forge, and are convenient for operations on a small scale.

RETORTED BULLION.—In addition to the gold and silver contents, the retorted bullion of silver mills usually contains lead, copper, and a slight amount of iron.

In retorting amalgam which contains a large quantity of copper a porous sponge, consisting principally of copper, but containing some silver and lead, is found on the top of the retorted bullion. Wherever the air reached this porous mass the metallic copper is converted into oxide. This substance is the bugbear of the melter, for the ordinary temperature of the furnace will not melt and reduce it, but converts it into a plastic mass, which no amount of flux seems to affect. This alloy contains from 20 to 30 per cent. of silver, and should never be thrown away. A high temperature will reduce and melt it, or it can be roasted, ground, and the copper extracted with sulphuric acid; the residue, consisting of silver and lead, can then be melted into bullion.

Certain alloys of copper, lead, and silver seem to retain a small percentage of quicksilver even after the bullion is melted; how much is not known, but it is sufficient to produce a strong reaction for quicksilver when tested, and its frequency renders the Gay-Lussac wet assay an untrustworthy method for such bullion.

MELTING FURNACES.—Melting furnaces are all very similar in construction. They are usually about 16 inches square and 18 inches deep, the top sloping toward the front. The materials are common brick, fire-brick, and cast iron for doors, etc., with wrought-iron ties.

CRUCIBLES.—A No. 50 or a No. 60 Dixon black-lead crucible is the kind mostly used for melting silver bullion. These crucibles last for from fifteen to twenty-five melts.

FLUXES.—Either slag from assaying, or borax, bicarbonate of soda, and saltpeter, are the fluxes usually employed in melting. Sometimes sulphur is used where there is much iron in the bullion.

AGITATORS.—Agitators are not very frequently used. Where they are employed it is more for the sake of concentrating the settler sands, sweepings, etc., than for catching amalgam. They are usually 7 feet in diameter and about 3 feet deep. The assay value of the sands recovered in them is usually higher than that of the tailings and less than that of the ore. Agitators are generally geared to make twelve revolutions per minute.

TAILINGS.—The tailings of free silver ores are almost always saved, those from roasted ore scarcely ever.

Tailings from the battery of a gold mill are handled in different ways, but the following is the usual method: After passing through the screens, the tailings, which contain considerable gold amalgam when battery amalgamation is practiced, flow over an amalgamated copper plate or silver-plated copper plate, on which most of the quicksilver alloy is caught. This plate is as wide as the battery screen and usually from 3 to 5 feet long, and is called the apron. From the apron the tailings flow into sluices in which are also amalgamated silver or copper plates, alternating with riffles or boxes, for catching quicksilver, and finally reach sluices in the bottoms of which blankets are laid. On these blankets the sulphurets, which are usually quite rich in gold, are caught. After leaving the blanket sluices the tailings sometimes run into a concentrator, in which further valuable contents are recovered from them. The Hendy concentrator, the one most employed in California, is usually placed after the plate sluices

and before the blankets. Buddles are also often used, as well as the Frue vanner. The blankets used are generally 20 inches wide, and are manufactured for the purpose by woolen-mills in San Francisco. The arrangement of amalgamating and concentrating apparatus in gold mills varies greatly, however; at the Idaho mill, for example, there is no battery amalgamation, and the pulp from the battery is immediately concentrated on blankets. The concentrations are treated in pans, and the tailings from the blanket sluices pass over riffles and other amalgamating apparatus to buddles.

GRADE OF SLUICES.—The grade given to blanket sluices is usually from three-quarters to 1 inch per foot, depending on the specific gravity and the fineness of the ore and the proportion of sulphurets contained in it. Sometimes the grade is increased to as much as 3 inches to the foot. The apron used in gold mills has always more grade than the sluices, and in many mills there is an arrangement by which the end of the apron can be raised or lowered as different peculiarities of the ore may demand.

PERCENTAGE OF SULPHURETS.—The percentage of sulphurets in California gold ores is very varied. The average is about 2 per cent. These sulphurets, when concentrated, are worked in different ways. Where rich, the best method is to roast, chloridize with chlorine gas, and leach. One or two per cent. of salt added before roasting facilitates the formation of the terchloride of gold and reduces the quantity of chlorine gas required. That terchloride of gold can be made by roasting sulphurets containing gold with salt is a well-established fact, but although at one stage of the process most of the gold is in the form of terchloride, upon cooling this compound is partially decomposed, a portion only of the gold remaining combined with chlorine. In making the chloridation assay of roasted silver ores containing gold it has been noticed that a portion of the gold is always leached through the filter, showing the presence of terchloride. The cost of such chloridation is about $10 per ton. Where the sulphurets are poorer they are worked in pans or revolving barrels.

WEATHERING OF CONCENTRATIONS.—Concentrations are allowed to weather from three months to a year, salt sometimes being added to assist the decomposition when it is the custom to work them in pans, etc.

PERCENTAGE RECOVERED FROM CONCENTRATIONS.—The Plattner chloridation process and its modifications save 90 per cent. and upward of the gold contained in sulphurets, but the percentage obtained by the other methods is much less. It depends on the character of concentration, length of exposure to weathering, and the process by which the sulphurets are worked. The yield by other methods of chloridation often falls below 50 per cent., though usually it is higher.

Blanket sluices are of little use in silver mills except where the ore, although mainly free, contains rebellious sulphurets, as is the case on the Comstock and at some places in Idaho. At the California mill about 10 per cent. of concentrations are obtained per day. These are allowed to weather from one to six months, salt being added, and are worked in pans.

TREATMENT OF TAILINGS FROM SILVER ORES.—With that class of silver ores which is treated raw it is rarely possible to extract such a percentage as to render the tailings worthless, and therefore these are commonly saved and allowed to weather, salt sometimes being added to assist the decomposition. As a rule, however, there is enough salt remaining in the tailings after working the ore to produce in the course of a year or two the required effect. It must be remembered that, no matter how fine a particle of tailings may be, there can still be a particle of silver mineral in the center of it so completely enveloped by earthy material that chlorine cannot act upon it and quicksilver cannot touch it. When tailings are treated, only that portion of silver is amalgamated which is exposed to contact with the quicksilver. As the outsides of these tailings particles have already been once subjected to the influence of chlorides and quicksilver, the amount of silver which can be recovered by a second amalgamation, of course taking it for granted that the ore has been properly treated in the first instance, except where long-continued grinding is practiced or where the character of the gangue has been changed by weathering, is exceedingly small. The percentage extracted from tailings does not often exceed 50 per cent. of the assay value, and generally falls far below this point. With the tailings from roasted ore, which are of lower grade than those from raw working, it is still more difficult to obtain the silver.

SLIMES.—Slimes sometimes assay more than the ore itself, sometimes less. The percentage of slimes escaping from wet-crushing mills varies from 1 to 15 per cent., according to the character of the ore. Ores containing much iron oxide generally produce the most slime. The slimes are usually first caught in large tanks, and then in shallow ponds. Eventually very little escapes if proper settling room is provided.

SALIVATION.—Only a few cases of sickness through salivation have been reported. The bursting or imperfect luting of retorts and the cleaning up of pans while still hot are frequent causes.

SAMPLES OF ORE.—Samples of ore are sometimes taken from each car-load at the mine. This is the case at the California, where a handful is taken from each car. When the ore of a mine is treated by a custom mill ore samples are often taken by the mine owners as a check upon the working of the mill.

BATTERY SAMPLES.—Battery samples are always taken at the mill, and in wet-crushing generally in the following manner: Every half hour or hour a rectangular iron box, or dipper, is passed along under the lips of the mortar where the pulp falls into the sluices, and a portion of the slimes and sand is taken, care being observed to prevent concentration by the overflowing of the box. This sample is put in a bucket with others, and at the end of twenty-four hours the clear water is poured off and the collective samples for the day are dried and prepared for assay.

In dry-crushing mills it is usual to take the sample by passing a box along the lower part of the screen every hour or so. Sometimes the sample is taken from the conveyor or from the pulp in the bins.

TAILINGS SAMPLES.—Tailings samples are taken from one or all of the discharge plugs of the settler or are dipped from the top before each plug is drawn. A very good way is to dip a small gas-pipe into the settler close to the top, one end of the pipe being closed with the finger, and withdraw a portion of the pulp.

BULLION SAMPLES.—Silver bullion is sampled by taking a dip from the melted mass after stirring, or a little is poured into water while the crucible is still nearly full, and a little more when it is nearly empty. Either method is good. Gold bullion is sampled by chipping two diagonally opposite corners of the bar after it is cast.

ORE ASSAYS.—Ore assays are generally made in crucibles, though with very base ores scorifiers are sometimes used. They are seldom corrected for loss in assaying.

ROASTING FURNACES.

SYSTEMS OF FURNACES.—There are many different kinds of furnace in use for chloridizing ore. Among the more common types may be mentioned the Howell, Brückner, White, Stetefeldt, O'Harra, and ordinary reverberatory. The Howell, Brückner, and White furnaces are revolving cylinders. The axes of the Howell and the White furnaces are at an angle of a few degrees to the horizontal, the ore being fed at the higher end and discharged at the lower. In the White furnace the ore and the flame from the fire-box enter the furnace together at the higher end. In the Howell the ore is fed in at the higher end and the flame enters at the lower. This constitutes the material distinction between these two furnaces, and the difference is in favor of the Howell. The Brückner furnace is a cylinder of boiler iron, with ends usually made of the same material, though sometimes they are of cast iron. In the center of each one of these ends, or heads, there is a hollow trunnion, through which the flame enters or passes out of the cylinder. The axis is horizontal, but, like the Howell and the White, the furnace revolves on a series of wheels or rollers. The motion is conveyed to all these furnaces by a system of gearing, a belt of cogs passing around the outside of the cylinders, which gears with a small spur-wheel on a counter-shaft below the furnaces. By an improvement in the gearing of the Brückner the speed may be varied from zero to six revolutions per minute, according to the requirements of the roasting process. In the Brückner furnace the charge of about 3,000 pounds is introduced through a door in the cylinder, placed half way between the two ends, which is closed by means of a clamp. These furnaces are also constructed with two doors opposite each other. A characteristic feature of the Brückner cylinder is the diaphragm, which consists of iron plates about one inch thick fastened to tubes passing through the cylinder at right angles to its axis. The plane in which these tubes are placed makes an angle of about 30° with the axis of the cylinder, so that the line where the plates and cylinder join is an ellipse. This diaphragm extends to within 18 inches of each end, and when the furnace revolves it induces a circulation of the pulp from one end of the cylinder to the other. Although this diaphragm gives an almost perfect motion to the ore, it has several disadvantages, among which are the following: The cast iron of which the plates are composed is corroded by the action of sulphur and chlorine, and the lively motion conveyed to the pulp causes a great portion of it, sometimes as high as 30 per cent., to be carried into the dust chambers. A great part of this dust, too, leaves the furnace before it has had time to be roasted, and thus escapes decomposition altogether. In consequence of these disadvantages the diaphragm is now usually omitted. Although the furnace, as at present constructed, does not chloridize to quite as high a percentage as it would if provided with a diaphragm, it has been proved to be far better suited to the economical working of ores. When the charge has been properly roasted, it is discharged through the doors by opening them and revolving the cylinder. As these furnaces are at present built, the speed can be increased when it is necessary to discharge by introducing a gear-wheel of larger diameter than that which ordinarily gives motion to the furnace.

The Stetefeldt is a high-shaft furnace, into which the flame enters from two fireplaces on the sides at the bottom, the ore, mixed with salt, being fed into it at the top. The fumes and dust pass out through a flue at the top, descend, and, after passing through the flame of a smaller auxiliary fire, are conducted to the dust chambers, whence the fumes escape through the stack. The ore occupies only a second or two in passing through the flame, but it is retained in the heat at the bottom of the furnace three-quarters of an hour before drawing the charge. The auxiliary fire has also been applied in connection with the revolving cylinders, and with good results.

The reverberatory furnace, as applied to the chloridation of silver ores, has sometimes one hearth, and sometimes two or three hearths. Where several hearths are used, the ore is first put into the one nearest the flue, and after roasting a time is raked to the next, and finally to the last, near the fireplace. Thus, in a furnace with three hearths, there are always three charges in different stages of roasting.

The O'Harra furnace is a brick double-deck reverberatory furnace, 9 feet high, 8 feet wide, and 60 feet long, in which the ore is stirred by scrapers or hoes attached to an endless chain moved by the mill machinery. The two hearths are level, one above the other, and 47 inches apart (arches 10-inch spring), 60 feet long, and only closed at the ends by hinged sheet-iron doors. These doors close the furnace so that the draught is not injuriously affected, and also enable the scrapers to pass under them readily. There are four fireplaces, two on each side, so arranged that all may be used to heat the lower hearth, or two of them may heat the upper hearth. The draught is through a

stack connecting with flues from the arches over the hearths. The endless chain passes over both hearths in opposite directions and over a pulley at each end of the furnace. To one of these pulleys power is transmitted by spur or friction gearing. To the chain at equal distances apart are attached two scrapers. Each of these carries 14 hoes—plates of wrought-iron about the size of a hoe—which are dragged along the hearths through the ore. These hoes are set at a slight angle with the chain, thus moving the ore somewhat forward as well as turning it over. The hoes of one scraper are set in a reversed position from those of the other; thus the ore is not pushed to the center or sides of the hearth, and the furrow made by one scraper is filled by the next. As the links of the chain and the scrapers are cooled by passing from one hearth to the other through the outer air, they are but little attacked and last for months.

It is not absolutely necessary to line any of these furnaces with fire-brick, but it is always best to use fire-proof material in the neighborhood of the flame. As a rule, fire-brick are much harder than ordinary brick, and for that reason are better suited to stand the wear and tear of a revolving furnace. There is not much difficulty in keeping the brick in place in the Howell and the White furnaces, their diameter being small, but with the Brückner it is otherwise. The large diameter of this furnace causes the arch to be insecure unless the brick are good and are put in very tightly. A very good method of increasing the security of the lining is to divide the circular arch into four parts by running flanges of boiler plate the length of the cylinder, thus making four independent arches. For this furnace it is cheaper in the long run to use the best fire-brick and as little clay as possible. Salt and ashes are said to make a very good mortar for laying the bricks in place, and they certainly form a mortar which does not contract on being exposed to heat. The heads of the Brückner furnace are usually lined with the best fire-clay, tamped around and over projections of iron, or large brick are molded in the form of segments of a circle and fastened to the heads by clamps and bolts.

STATISTICS.—Of the ninety-five roasting furnaces reported, eighty-nine were in use during the census year. More than one-half, fifty-seven, are of the cylinder type, while twenty-nine are reverberatories and nine are shaft furnaces.

TABLE CXIII.—ROASTING FURNACES IN AMALGAMATING MILLS.

ARIZONA.

County and district.	Mill or works.	Number of furnaces.	Number in use.	Capacity in twenty-four hours.	Character.
				Tons.	
MOHAVE.					
Hualapai	Mineral Park	1	1	6	Brückner cylinder.
PIMA.					
Arivaca	Arivaca	1	1	3½	Stewart reverberatory.
PINAL.					
Globe	Isabella	1	1	15	Howell cylinder.
Pioneer	Silver King	1	1	6	Brückner cylinder.
YAVAPAI.					
Peck	Peck	1	1	15 to 18	White cylinder.
Pine Grove	Bradshaw Basin	1	1	8	Do.
Tiger	Tiger	1	1	15 to 18	Do.
	Tip-top	1	1	15	Howell-White cylinder.

CALIFORNIA.

AMADOR.					
Sutter Creek	Amador reduction works	1	1	4½	Reverberatory.
Do	Phœnix reduction works	2	2	3	Do.
Do	Sutter Creek	1	1	3	Do.
NEVADA.					
Nevada City	Pioneer reduction wrorks	1	1	4	Crosby cylinder with reverberating finishing hearth.
Do	Providence	1	1	5	Reverberatory.
PLUMAS.					
Quartz township	Plumas-Eureka	1	1	1½	Brückner cylinder.
SHASTA.					
Pittsburgh	Copper City	2	2	40	O'Harra automatic stirring hearth.
SISKIYOU.					
Sawyer's Bar	Klamath	1	1	2	Reverberatory.
South Fork Salmon	Black Bear	1	1	6	Do.

TABLE CXIII.—ROASTING FURNACES IN AMALGAMATING MILLS—Continued.

County and district.	Mill or works.	Number of furnaces.	Number in use.	Capacity in twenty-four hours.	Character.
COLORADO.					
ARAPAHOE.				Tons.	
Argo	Boston and Colorado reduction works	8	8	3½ to 3¾ each	Reverberatory (roasting matte).
BOULDER.					
Grand Island	Caribou	4	4	5½ each	Brückner cylinder.
CLEAR CREEK.					
Griffith	Clear Creek	6	6	3 each	Do.
Do	Farwell reduction works	5	5	2½ each	Do.
SAN JUAN.					
Eureka	Melville	1	1	7	Reverberatory.
DAKOTA.					
LAWRENCE.					
Bear Butte	Florence	2	2	6 each	Brückner cylinder.
IDAHO.					
ALTURAS.					
Middle Boisé	Buffalo	3	3	10	Hunt, Douglas & Stewart reverberatory.
Do	Davis tailings mill	1	1	1½	Reverberatory.
BOISÉ.					
Banner	Elmira	2	2	12½ each	Do.
LEMHI.					
Yankee Fork	General Custer	2	.....	28	Hyde-Brückner cylinders.
OWYHEE.					
Wagontown	Tremont	1	.....	10	Reverberatory.
MAINE.					
HANCOCK.					
Sullivan	Sullivan	1	1	10 to 15	Howell cylinder.
MONTANA.					
DEER LODGE.					
Flint Creek	Algonquin	1	1	20 to 30	Howell cylinder.
Summit Valley	Alice	2	2	12 each	Do.
NEVADA.					
ELKO.					
Columbia	Columbia Con	1	1	13 to 18	Howell-White cylinder.
Tuscarora	Grand Prize	2	2	15 each	Do.
Do	Independence-Navajo	1	1	20	Do.
ESMERALDA.					
Columbus	Northern Belle	2	2	60 each	Stetefeldt shaft.
Oneota	Indian Queen	1	1	10	Howell cylinder.
EUREKA.					
Cortez	Wenban	1	1	5	Brückner cylinder.
HUMBOLDT.					
Mount Rose	Paradise Valley	1	1	15	Howell-White cylinder.
Winnemucca	Humboldt reduction works	2	1	10	Brückner cylinder, 10 tons capacity, in use; also Aiken shaft, not in use.
LANDER.					
Lewis	Storr & Grove	3	3	5 each	Brückner cylinder.
Reese River	Manhattan	1	1	22	Stetefeldt shaft.
LINCOLN.					
Eldorado	Southwestern	1	1	20	Howell cylinder.
NYE.					
Morey	Morey	1	1	20	White cylinder.
Tybo	Tybo	1	1	30	Do.
Union	Alexander	2	2	20 to 25 each	Howell-White cylinder.
WHITE PINE.					
Cherry Creek	Star	3	3	11 each	Howell cylinder.
Ward	Martin White	4	4	12 to 15 each	Do.

TABLE CXIII.—ROASTING FURNACES IN AMALGAMATING MILLS—Continued.

County and district.	Mill or works.	Number of furnaces.	Number in use.	Capacity in twenty-four hours.	Character.
NORTH CAROLINA.					
CABARRUS.					
.....	American	1	1	6	Meares' revolving hearth.
MECKLENBURG.					
.....	New York and North Carolina reduction works.	1	1	20	Robinson.
ROWAN.					
.....	North Carolina	1	1	6	Reverberatory.
OREGON.					
GRANT.					
Granite	Monumental	1	1	20	Howell-White cylinder.
UTAH.					
JUAB.					
Tintic	Crismon-Mammoth	1	1	35	Howell-White cylinder.
Do	Ely	1	1	20 to 25	Aiken shaft.
SALT LAKE.					
West Mountain	New York and Utah reduction works	1	.....	a 10	Brewster's rotary hearth.
SUMMIT.					
Uintah	Ontario	3	2	72	Two Stetefeldt shaft furnaces, 25 tons capacity each, in use; 1 Howell cylinder, capacity 22 tons, not in use.
UTAH.					
Tintic	Tintic	1	1	24	Stetefeldt shaft.

a Estimated.

DIMENSIONS OF FURNACES.—The dimensions of the Howell furnace are as follows: Length, from 16 to 27 feet; inside diameter, from 24 to 38 inches. The furnace is made in several sections, which are bolted together. Formerly the two sections near the fireplace were made larger than the others, and were only lined with brick. It has been found good policy, however, to make all the sections of the same diameter and line the cylinder with brick throughout.

The White furnaces are usually shorter than the Howell and of greater diameter, and are lined throughout their whole length. The bricks forming the linings of these furnaces are usually set on edge.

The Brückner cylinder is usually 12 feet long and 5 feet in diameter inside, the bricks being laid flat. Some furnaces, however, have been constructed for the Ætna company at Galena, Nevada, 16 feet long and 6 feet 6 inches in diameter. These furnaces are provided with four discharge holes.

The Stetefeldt furnace is built of different sizes. The shaft proper is usually between 30 and 40 feet high.

The usual size for a reverberatory furnace hearth is 12 feet square, the arch being made low, in order to keep the flame as near the pulp as possible, but they are sometimes much longer.

In the Howell furnace the discharge end is from 7 to 10 inches lower than the feed end. The cylinder is geared to make from three to six revolutions per minute, according to the diameter of the furnace, the angle of incline, and the character of the process. The less the diameter the greater should be the speed. These furnaces are now arranged so that the speed can be increased or decreased at will, so as to vary the length of time that the ore requires to pass through. By decreasing the speed the ore is retained longer in the furnace, thus facilitating the working of baser ores. The Brückner cylinder ought to be geared so as to make one revolution in two and a half or three minutes if 5 feet in diameter, or one revolution in four minutes if of the larger size, 6 feet 6 inches in diameter.

REPAIRS.—Neither of the cylinder furnaces require frequent repairs if the lining has been properly secured. The Stetefeldt shaft furnace, when built of good material, seldom gets out of order, and repairs may be limited to an occasional renewal of the brick in the fireplaces.

The repairs needed in a reverberatory furnace depend upon the fire material used in building it, upon the form of the arch (flat arches being more liable to fall in than round), and upon the care with which it is anchored. Generally these furnaces last for years, but slight patching here and there being required.

CAPACITY OF THE DIFFERENT FURNACES.—The Howell, the White, the Stetefeldt, and the reverberatories with several hearths or with a single very long one are continuous furnaces; the Brückner and the reverberatory with a single short hearth finish a given charge before a second is introduced. The capacity of the ordinary-sized Howell and White furnaces is from 10 to 15 tons, although over 20 tons are sometimes put through these furnaces in twenty-four hours, and at the Alexander mill, in Nevada, when working on ore containing most of the silver as chloride, a

capacity of 50 tons was reached. The 12 by 5 feet Brückner cylinder will hold about 2 tons of ordinary ore, the amount put through in twenty-four hours depending on the time needed to roast, which is very different for different ores. A Brückner will ordinarily work 6 tons a day. The Stetefeldt furnace can work from 20 to 60 tons, according to its size, in a day, and the reverberatory furnaces from 1,000 to 2,000 pounds to the charge. The only O'Hárra furnaces reported have a capacity of 20 tons each per twenty-four hours.

METHODS OF CONVEYING ORE TO FURNACES.—The usual way of carrying ore from the battery to the furnaces is by means of screw conveyors and elevator belts with sheet-iron cups attached. Sometimes cars are used for this purpose.

METHOD OF FEEDING ORE INTO FURNACES.—In the Howell and the White furnaces the ore, mixed with salt in the battery or after crushing, falls from the elevator into a chute, which carries it into the upper ends of the furnaces. For the Brückner the ore and salt are crushed in the battery together and conveyed to the hopper above the furnace, or the salt, having been ground fine in a mill or crushed by a separate battery, is added after the charge is partially roasted. At the Custer mill, in Idaho, the salt is pulverized separately, but is added with the charge of ore. The same methods are used with the reverberatory furnaces.

In the Stetefeldt the feed of the ore and salt is regulated by mechanical appliances, so that the supply of each entering the furnace can be adapted to the necessities of the ore.

MANIPULATIONS IN ROASTING.—In the ordinary reverberatory the work to be done consists in raking and hoeing the ore from the flue end of the furnace to the fire-bridge and back and forth, so as to expose every particle first to the oxidizing influence of the air and then to the chloridizing effect of the decomposing salt. The quality of the roasting depends almost entirely upon the care and diligence with which this manipulation is performed. After the roasting is completed the ore is raked from the furnace to the cooling floor and there sprinkled with water, either immediately or after an interval. In the Stetefeldt, every three-quarters of an hour the door at the bottom of the shaft stack is opened, and the ore which has collected at the bottom is drawn out upon the cooling floor and sprinkled.

In the Howell furnaces the ore falls from the lower end of the cylinder into an iron box set in a chamber between the fire-box and the furnaces and closed by iron doors. When the box is full the doors are opened, and it is swung by means of a crane out upon the cooling floor and dumped. It is then replaced, and the doors are closed. A simple brick oven may be substituted for this movable box.

When the charge in the Brückner is completely roasted the furnace is stopped, and, the discharge doors having been opened, it is again put in motion, and as the cylinder revolves the ore falls directly on to the cooling floor. It is almost completely discharged in ten revolutions, after which another charge is introduced.

Whichever furnace is employed the product is, or should be, the same. The color varies from a light reddish-yellow to a dark brown, its shade depending on the amount of oxide of iron. It should have a light, porous, and woolly appearance, and when horned out should show no sulphurets.

TEMPERATURE MAINTAINED.—In the Brückner and the reverberatory furnaces, after the desulphurization of the ore, which requires from two to eight hours, the temperature is raised and the chloridation period begins, which lasts from two to four hours. In the other furnaces, with one exception, a uniform temperature, about a cherry-red, is maintained at the fire-bridge, the ore being exposed to higher and higher temperatures as it passes through the furnace. In the original White furnace the ore is heated to the highest temperature at the point of entry.

TENOR OF ORE TO BE ROASTED.—Silver ores which require roasting before they can be amalgamated are of very varied composition. There are some ores which contain so little sulphur that only an incomplete chloridation is obtained unless sulphur, either in the form of brimstone, of iron pyrites, or of copperas, is added before the ore is introduced into the furnace, sulphur in some form being necessary for the decomposition of the salt and the liberation of the chlorine. There are other ores, on the contrary, which contain so much sulphur in the form of sulphides that a long oxidizing roasting is necessary before they can be prepared for chloridation. The typical roasting ore is quartz containing silver minerals and from 10 to 15 per cent. of iron pyrites, with a slight admixture of copper sulphides. Calc-spar, braunspar, and fluorspar, if present in any quantity in an ore, retard the chloridation, as they absorb a large part of the sulphuric acid. Arsenic and antimony minerals increase the loss of silver by volatilization. Zincblende requires a long oxidizing roasting to convert it into sulphate, and then a high temperature must be maintained before it will decompose the salt. Where there is a large amount of zinc in the ore the chloridation is an imperfect one. Lead and copper contaminate the amalgam and bullion. All these minerals involve the use of a large percentage of salt in roasting, but if present in only small quantities they do not perceptibly affect the chloridation.

In mixing ores the sulphur and the silver contents of the charge are kept at those percentages which have been determined in actual practice to be the most favorable under the circumstances to the chloridation of the silver. The effort made to obtain rational rules as to the most expedient relations of silver, sulphur, salt, etc., was a failure, most of the managers having determined their mixtures empirically and knowing nothing definitely of the percentage composition of their ores. The richer and baser the ore the more salt it requires.

DURATION OF THE ROASTING PROCESS.—In the Howell and the White furnaces the ore is exposed to the flame from seven to twenty minutes; in the Brückner and the reverberatory from five to twelve hours, and in the Stetefeldt it is about two seconds falling through the flame, and remains forty-five minutes at the bottom of the furnace.

OXIDIZING-ROASTING.—When ores contain much arsenic and antimony much salt is saved by exposing them to a preliminary oxidizing-roasting. This may easily be done in reverberatory or Brückner furnaces, but in the Stetefeldt, the Howell, and the White furnaces it is not practicable. In roasting ores free from arsenic and antimony there appears to be no advantage in delaying the addition of salt.

PERCENTAGE OF SALT USED.—When the salt is mixed with the raw ore there is not much difference in the amount required to roast a given ore in any of these furnaces, but the Stetefeldt and the Brückner are supposed to require a smaller percentage than the others. From 3 to 15 per cent. of salt, according to the character of the ore, are the usual limits, 8 per cent. being the average. Salt is usually the chief item of expense in roasting ores, and millmen frequently use more than the quality of the ore demands. They think it always best to be on the safe side, and by allowing a certain margin of excess often considerably increase the expense.

WHEN SALT IS ADDED.—Generally salt is added with the raw ore, though in working very base ores in the Brückner and the reverberatory furnaces it is customary to add it at the end of the oxidizing period.

SULPHUR CONTENTS.—The percentage of sulphurets in roasting ores varies from 1 to 70 per cent. The closeness with which it is necessary to keep to a given sulphur content varies with the different furnaces. In the Stetefeldt there is but little latitude, from 3 to 5 per cent. sulphur being the limits. If this quantity will not liberate chlorine enough to chloridize the silver, the ore must be reduced in grade by the admixture of poorer qualities. In the White and the Howell there are larger margins, and in the Brückner and the reverberatory the very basest ores can be worked.

PERCENTAGE OF SILVER CHLORIDIZED.—The percentage of silver chloridized varies from 75 to 90 per cent. in these different furnaces, it seeming to depend more upon the character of the ore and the method of working than upon differences of construction and manipulation. The difference in this respect is perhaps a little in favor of the Brückner and the reverberatory, as these furnaces permit of an oxidizing-roasting before the salt is added.

LABOR.—In all these furnaces, except the reverberatory, a man can roast 5 tons of ore per shift. One man can easily attend to two Brückner furnaces. In the reverberatory it is fair work for one man to roast a ton per shift.

FUEL.—Wood is the fuel used in all these furnaces except in the Stetefeldt, where some charcoal is occasionally burnt. This wood is of many different kinds, and its value as fuel is chiefly governed by its weight. The different furnaces require on the average the following weights of wood to roast a ton of ore, the weights being calculated on the basis of 2,200 pounds per cord as the average:

	Pounds.
Howell	300
White	300
Brückner	900
Reverberatory	600
Stetefeldt	200

The Stetefeldt furnace uses less fuel than the others, because it is built solidly of brick and retains the heat better; the Brückner uses the most, because it is a large cylinder, and it is necessary to reheat it each time it is discharged.

POWER.—The power used to drive the mechanical furnaces is estimated at about two horse-power for the Brückner and one and a half horse-power for the White and the Howell furnaces.

LOSS OF WEIGHT OF ORE IN ROASTING.—The loss of weight of ore in roasting ranges from 3 to 15 per cent. Very base ores, of course, lose much more weight than freer ores. Leaving the sodium sulphate out of consideration, the tendency of the roasting process is to reduce the weight of the ore. The roasted product, as a rule, contains considerable quantities of soluble metallic chlorides and sulphates.

DUST-CHAMBERS AND FLUES.—The best arrangement of dust-chambers and flues is that of the Stetefeldt furnace. The system consists of a series of dust-chambers, sometimes as many as twelve, through which the dust and fumes pass, giving the dust an opportunity to settle, and of a long flue connecting with a stack, which is generally placed on a hill-side at some distance from the furnace.(*a*) The dust-chambers nearest the furnace are opened several times a day and the flue-dust is raked from doors at the bottom. The long flue is opened once in about six months, when the furnace is shut down. Two-thirds of the flue-dust is deposited in the first two or three chambers.

The flues and dust-chambers of the other furnaces are arranged in a somewhat similar manner, except that they are not usually so complete. The dust-chambers are often placed under the dry kiln, so that the heat from the furnace can be used to dry the ore, and the smoke-stack is often built in the mill itself, though it may better be placed as indicated in the preceding paragraph. The practice of placing the drying kilns over the dust-chambers is to be recommended only when draught is cheaper than fuel, which, however, is usually the case.

AMOUNT OF FLUE-DUST CAUGHT.—The amount of flue-dust caught per ton of ore roasted depends on many circumstances, such as the character of the ore, its fineness, the style of furnace, and the draught. Those ores give the most flue-dust, which, before they are roasted, are light and porous and contain oxide of iron. The ores which give the least are hard quartz ores with sulphurets. Those ores which contain a large proportion of

a By thus taking advantage of the topography the expense of a high stack is avoided.

sulphurets do not, of course, need to be crushed as fine as those which contain little, the sulphurets being readily attacked by oxygen and chlorine when unprotected by a coating of minerals not affected by these gases. When there is no sulphur present it is necessary to add it as pyrite, brimstone, or, best of all, as copperas. The ore should then be fine, to facilitate the immediate and complete action of the chlorine.

If the reverberatory furnace is properly handled, it produces the least flue-dust, for the motion of the ore is less violent than in the others. With care in the reverberatory furnace the amount of flue-dust can be limited to 2 per cent. From the nature of the Stetefeldt furnace a considerable amount of flue-dust passes into the dust-chambers, but as practically all of it settles there, and as owing to the auxiliary fire it is chloridized to a higher percentage than the ore itself, this fact is of no importance. As much as 10 per cent. sometimes passes over. This is also true of the Howell furnace, except that the dust is usually not so well settled as in the Stetefeldt. At the Grand Prize, in Nevada, the flue-dust chloridized 5 per cent. higher than the ore itself, and at other mills this higher chloridation of the dust is very frequently the case. With the Brückner furnace the amount of flue-dust is usually not large, but it is not chloridized as high as the ore, and sometimes requires a second roasting.

The draught in all these furnaces can be regulated by two dampers, one between the furnace and the dust-chambers, the other in the smoke-stack.

Loss of flue-dust.—The actual loss of flue-dust is very slight with most ores where the furnace has plenty of dust-chambers and long flues, and it probably does not often exceed 1 per cent.; but where the ore is very finely divided, even under favorable circumstances this loss may reach 5 per cent. Extensive dust-chambers are usually desirable.

As regards the loss of silver and gold by volatilization, no reliable data are available. That there is such a loss cannot be questioned, but at present there is no accurate means of estimating it. Except with ores containing much arsenic, antimony, and zinc, it is probable that it never exceeds 1 per cent.

Difference in composition between flue-dust and roasted ore.—Flue-dust is different in composition from roasted ore. It is lighter, and its color is usually a shade darker. It contains ashes and charcoal, as well as more of the base-metal chlorides than the roasted ore. It often contains fine undecomposed sulphurets. The flue-dust from the Stetefeldt and the Howell furnaces is chloridized higher than the roasted ore. This is due to the action of the auxiliary fire through which the dust falls as it comes from the furnace. In some places there is an arrangement by which a small percentage of fine salt can be mixed with the dust as it passes through the flame to assist the chloridation. The flue-dust from the other furnaces is chloridized lower than the ore, and, although the auxiliary fire has been introduced in the construction of Brückner furnaces, it has not been found to have the desired effect. In the Brückner furnace the cause of this may be that the greater part of the flue-dust passes over into the chambers when the ore is first charged, and as it is not at all roasted the auxiliary fire is not capable of chloridizing it. The tail fire is more beneficial with continuous furnaces than with those which receive a charge at stated intervals.

Different kinds of furnaces as compared to each other.—The principal advantages and disadvantages of the furnaces described may be briefly stated as follows:

The Howell, of all the mechanical furnaces, is the one which is most easily handled. It is not an expensive furnace, and requires little power and few repairs. It has a continuous feed and discharge, which lightens the labor required. It is the furnace which, with the exception of the Stetefeldt, requires the least fuel to roast a ton of ore. Its flue-dust is chloridized to a higher per cent. than the roasted ore, and, with the possible exception of the Stetefeldt, it requires less manual labor to run it. Like all continuous furnaces, it requires the ore to be crushed fine and needs a large percentage of salt when the ore is light or at all base. These points, however, are not serious disadvantages. What prevents the furnace from being universally adopted is the fact that it is not available for the basest ores. The length of time during which a particle of ore is exposed to the action of the flame and the air is short, though in the latest furnaces the time has been considerably extended. The reason that this furnace is not adapted to chloridize the basest ores is that the period of oxidizing-roasting, which begins at the flue end of the furnace, is altogether too short to permit of any quantity of zincblende, galena, or other refractory minerals being oxidized, and they pass into the chloridizing portion before the metals are in a condition to combine with the chlorine gas. This defect of the furnace is of little importance as regards its availability in all cases where the ore is not of the very basest kind, and but very few of the ores of the Pacific coast are of such a character.

The White is a similar furnace to the Howell, and, except that the flame and the ore enter the cylinder together, there is no great difference in points of construction. As regards expense of building, power required to run it, repairs, continuous feed and discharge, and labor required in manipulation, what has been said of the Howell applies also to this furnace. The fact that ore and flame enter the cylinder together precludes the possibility of distinct oxidation and chloridation periods. It is necessary to crush the ore fine, and the flue-dust is not usually chloridized as perfectly as the ore, nor can the basest ores be worked in it.

The Brückner cylinder, like the reverberatory furnace, has the advantage that an ore which is in any way susceptible of chloridation no matter how base, can be effectually chloridized in it; but, unlike the latter furnace, the efficiency of the work does not depend upon the diligence of the roaster, whose business it is to stir the pulp. It chloridizes to a somewhat higher per cent. than the other mechanical furnaces, and requires less salt. These facts may be accounted for when it is remembered that the ore can be roasted sufficiently before the salt is added to

form the sulphates necessary to the proper decomposition of the salt, so that when that is added nothing but an elevation of temperature is needed to complete the process. On the other hand, it is a furnace which in some respects is inconvenient to handle and requires more power to drive, as the charge is a heavy one (from 3,000 to 4,000 pounds). The bricks forming the lining occasionally fall out, and the furnace needs, as a rule, more repairs than the others. It also consumes more wood, for reasons already explained. It is, however, the best mechanical furnace known for working very base ores.

The Stetefeldt furnace has the following advantages: Less power is required than for any of the other furnaces, and but few repairs are needed; it has a continuous feed and discharge; it requires the least fuel and the least labor of any per ton of ore roasted; and its ore and flue-dust are chloridized to a very high percentage. Its principal drawbacks are its original cost, for it must be built of good brick and well anchored, and that the ore worked in it must have nearly a fixed percentage of sulphur and nearly a fixed value in silver to be well roasted. Very low and very high grade ores cannot, therefore, be worked to advantage. The loss of silver and of gold in this furnace is very slight, and where there is a large quantity of ore to be roasted per diem and the ore is uniform and of a suitable composition this furnace is much to be recommended.

The reverberatory furnace does excellent work on all kinds of ore, and admits of any necessary modifications in the process; but the fact that it involves so much manual labor, thereby making the process a very expensive one, prevents it from being employed in any but very exceptional cases. Its first cost, however, is much less than that of a cylinder or shaft furnace, and also, of course, considerably within that of an O'Harra mechanical reverberatory. As the price of labor is nearly the same at points near main lines of communication and at localities far removed from them, while the cost of freight on the iron and the fire-brick involved in the construction of most of the furnaces increases very rapidly with the distance from the railroads, the reverberatory furnaces may often be the most economical in remote districts.

TYPICAL GOLD AND SILVER MILLS.

As specimen works, illustrating the two extremes in the amalgamating processes, the Ontario mill and the two mills of the Homestake company are mentioned below in some detail. The former is a type of the dry-crushing, chloridizing-roasting, pan-amalgamating mill, working on base silver ores. Its process is complicated, involving the repeated rehandling of material; and though in this mill the costs are brought as low as is consistent with good results the large force, extensive plant, and quantities of supplies required make the operation an expensive one. The latter works represent the treatment of free-gold ores brought to the greatest simplicity. Between these two extreme cases are many gradations in type, ranging from the simple water-power gold mills of California and the free-milling silver reduction works of Nevada, Arizona, Idaho, Montana, etc., up to mills employing processes comparable with that of the Ontario, and often working at a still greater expense.

THE ONTARIO DRY-CRUSHING 40-STAMP SILVER MILL.

The mill of the Ontario Silver Mining Company at Park City, Uintah district, Summit county, Utah, is a fine example of works in which dry-crushing and chloridizing-roasting precede pan amalgamation. The mill was built in the autumn of 1876. Stamps were dropped January 26, 1877, and, aside from a delay of six weeks in the latter part of 1878, when the hoisting works of the company were destroyed by fire, and another of nine weeks in the spring of 1880, while furnaces were in construction, besides stoppages of a few days for cleaning up and for minor repairs, the mill had been running steadily until visited by the census expert for Utah. The building is a large and commodious but somewhat unsymmetrical structure, many modifications and additions having been made. The plant and methods are designed for close and economical work. The total cost to the close of 1880 was $321,000.

PLANT.—The plant includes the following machinery: Two Blake rock-breakers; one Lane & Bodley hydraulic lift; two rotary driers, 24 feet long and having a grade of 9 inches; eight Cochrane & Hendy self-feeders, improved by the local engineer; forty 850-pound stamps, drop 8 inches, speed ninety-four drops per minute; double-discharge dry-crushing batteries, having No. 30 and No. 26 brass-wire screens; twenty-four combination pans; twelve settlers; one agitator; two clean-up pans; one quicksilver elevator; four retorts and two melting furnaces; one battery of five 400-pound stamps, 7- to 7½-inch drop, speed ninety per minute, and screen No. 20, for crushing salt; two Stetefeldt roasting furnaces, with necessary flue-dust chambers; one Howell roasting furnace and dust chamber; one 250 horse-power horizontal engine and four horizontal boilers. In connection with the mill the company also owns boarding and lodging houses, barns, water-tanks, blacksmith and machine shop, etc.

The ore, the hauling of which is charged to the mill, is dumped from the wagons upon iron grizzlies 9 feet long, set at an inclination of 30° and having 2-inch spaces. That which passes over the grizzlies goes to the two Blake rock-breakers and then falls with the fine ore into the mill bins, which hold several thousand tons. Cars are filled from chutes and hoisted 8 or 10 feet by the hydraulic lift. A laborer empties them into hoppers over the rotary driers, to which an ingenious self-feeding apparatus of local construction is attached. One-tenth of a cord of wood per ton of ore treated is used in drying. The driers dump upon the floor through a side chute. The ore is then shoveled into wheelbarrows and taken to the battery self-feeders. Screw conveyors and belt elevators next carry it to hoppers over the Stetefeldt furnaces.

Salt is not crushed with the ore, but in a separate 5-stamp battery. This battery is fed by hand, and discharges through a chute into a wheelbarrow, from which it is dumped into a hopper. Immediately under this hopper, and connecting with it by a short tube, is a small horizontal screw conveyor driven by a cone pulley. This carries the required amount of salt to a tube leading to the main ore conveyor, immediately beneath. By means of the cone pulley the speed of the conveyor can be regulated, and thus the required percentage of salt be added. At the time of examination the proportion of salt used was 18 per cent. of the weight of the dry ore. The pulp and salt are intimately mixed in the conveyors before reaching the furnaces.

The battery guides consist of pieces of oak wood having the fiber parallel to the stems, mortised into the ordinary guides. These are found to wear much longer than guides cut in the usual manner. The new die surface is about level with the lower edge of the discharge. The end and middle stamps are given a trifle more fall than Nos. 2 and 4. The order of drop is 1—4—2—5—3.

Steel shoes and dies had been in use for two years with fair results. They wear about a year, at the end of which time the surfaces are extremely irregular, usually showing several depressions from three-quarters of an inch to 1½ inches in depth and having worn away about one-sixth. The shoes are then refaced and used another year. Experiments were made with a combination of steel shoes and cast-iron dies, but no definite results had been reached at the time the mill was reported on.

Screens usually last thirty days. Only three stems had been broken in four years, the part affected by the guide bearings wearing out first. One set of twenty stems lasted three and one-half years; the other set only two and one-half years.

FURNACES.—The Stetefeldt furnaces at this mill are 38 feet from screen to hearth. The walls are made of double courses of brick, between which is a 3-inch space filled with ashes. The water-jackets at the top of the furnaces have been removed, as they were found to be unnecessary. Each furnace treats from 22 to 25 tons per day, but the possible capacity is somewhat greater. The amount of wood consumed in roasting is one-fifth of a cord per ton. The arches and bridge walls of the fire-boxes usually require repairing two or three times per year, the work occupying three or four days at each time. Charges are drawn into cars every hour from the hoppers, but only the lower portion of the ore is removed, so that practically ore remains in the furnace-pit from four to six hours. It is then dumped in a heap on the cooling floor and allowed to remain from sixteen to twenty-two hours before being wet down. It has been found that this increases the amount of silver chloridized several per cent. beyond that obtained when it is wet down immediately. During the year February, 1879, to February, 1880, the average percentage chloridized was 86½. At the time of the agent's visit, owing to improvements and experience, the average for ten days for both furnaces was 92.7 per cent.

The flue-dust assays much higher than the roasted pulp at the base of the shaft, but no average results were obtained. The flue-dust chambers are of brick, 10 feet wide, 16 and 18 feet high, and 30 and 44 feet long. These are divided by partition walls into smaller chambers 3½ feet wide. From these flues of considerable length lead to brick stacks upon the hill-side. The flue from the dust-chambers of the new Stetefeldt furnace is of brick, 300 feet long and 3½ by 5½ feet. The chimney, the base of which is perhaps 80 feet above the floor of the furnace room, is 87 feet high. It is about 5 feet square at the base and 3 feet square at the top.

A Howell furnace with flue-dust chambers and all the necessary appliances was built in the winter of 1879–'80. It is 24 feet long, with 52- and 62-inch cylinders. It ran only about twenty-five days, during which time a series of assays were made for the purpose of comparing the Stetefeldt with the Howell furnace, and the latter was then shut down. The comparative experiments were made by Mr. Stetefeldt.

AMALGAMATION.—After having been wet down the ore is taken in a car to the pan room. It passes over a pair of platform scales, where it is weighed, and two spoonsful are taken for the chloridation sample. The sampling spoons used are similar to a butter-tester in shape.

The pans, 5 feet 3 inches in diameter by 2 feet 10 inches deep, are charged with about 2,800 pounds (dry weight) of pulp, heated with live steam and run eight hours, the muller making sixty-five revolutions per minute. The temperature of the pans when first heated is 190° F.; at the end of two hours, 178°; in five hours, 170°; and shortly before discharging, 160°. Three hundred pounds of quicksilver are added per pan immediately after heating. Formerly it was the custom to add 1 and 1½ pounds of zinc per charge, and sometimes salt and iron turnings. This has been discontinued, as it lowered the fineness of the bullion from fifty to one hundred thousandths, and did not appreciably increase the percentage amalgamated or save the castings to any considerable extent.

The wings are not upon the sides of the pans, as has been ordinarly the practice, but are attached to a frame of 3- by 4-inch stuff running across the top and center of each pan. The wings are 1-inch boards, 2 feet long and 14 inches wide. The longer dimension is placed vertically and the shorter obliquely to the radii of the pan, 2 inches being left between the wing and the side of the pan and 7 inches between the wing and the sleeve of the muller.

The settlers are 8 feet by 3 feet 9 inches, make thirteen revolutions per minute, and retain a charge four hours. After a pan has been discharged into a settler, the latter is filled with water and run three and one-half hours, when it is emptied in half an hour by pulling two plugs.

The settler sands all pass through one agitator, 4 feet deep by 9 feet 4 inches in diameter, making twelve revolutions per minute, which had just been placed in position. No accurate data regarding the amount of quicksilver or amalgam caught could be obtained. Most of the tailings have been caught since September, 1878, and 20,000 tons, assaying $18, were supposed to be in the reservoirs at the time of examination. The quicksilver is strained from the amalgam through No. 0 duck bags. It falls into iron tubs, and thence runs to a tank. A rubber-belt conveyor, with small Russia iron buckets, takes it to a quicksilver reservoir above. From this there are two main lines of half-inch pipe, with branches to each pan, terminating in a hollow cylinder. This is supposed to hold 300 pounds. When it is full and the pan-charge ready, a plug in the bottom is withdrawn and the quicksilver runs into the pan.

SAMPLING.—The ore is weighed in the wagons as it comes from the mine. It is supposed to contain about 11 per cent. of moisture. The battery sample is taken from the screens at the top of the Stetefeldt every hour, these hourly samples constituting a 24-hour sample. After assaying, the percentage of salt used is allowed for in calculating the true battery-sample assay. Tailings samples are taken as usual. The chloridation sample previously mentioned as taken from the car gives the chloride assay by the common hyposulphite method; but a portion of this car sample is also leached, dried, and weighed, to determine its percentage of moisture and the quantity of soluble salts present. Assuming that the soluble salts are sodium sulphate and excess of sodium chloride, the assays made before and after roasting afford a means of comparison which is certainly better than nothing, and possibly sufficient to check the working of the furnace. As a means of comparing different roasting furnaces, such as the Stetefeldt and the Howell, however, it is manifestly insufficient, since soluble metallic salts are also formed in the roasting process. The percentage of soluble salts in the Ontario ore, after treatment in the Stetefeldt furnace, is from 18 to 28.

CLEANING UP.—The mill is thoroughly cleaned up once in three or four months, or when it shuts down for repairs; but a partial clean-up is made at the end of each month.

RETORTING.—The amalgam is taken on a car to the retort room. The retorts are circular, 14 inches in diameter, 5½ feet long, and have the vent at the upper part of the back end. They are charged with about 2,000 pounds, which fills them two-thirds full. Retorting is finished in from six to six and one-half hours from the time of sealing, a dull red heat being maintained during the last four hours. The mercurial vapor is condensed in a discharge pipe, 2 inches in diameter, which passes through a cylindrical water-jacket 4 feet long.

The old retorts lasted one and one-half years, running every other day. The newer ones are much thicker, and after having been in use two years appeared nearly as serviceable as ever.

MELTING.—The bullion, which is about one-seventh of the amalgam in weight, is melted in No. 50 Dixon crucibles, in fire-brick furnaces about 17 inches square. A little borax is added to flux the iron and sand, and the skimmings are saved and put through the battery once a year. The fineness of the bullion is 0.680 to 0.840, averaging 0.750, the base portion being chiefly copper.

LOSS OF QUICKSILVER.—Actual weighings have shown a loss of quicksilver of nearly 3½ pounds per ton of ore worked.

LOSS OF IRON.—It was estimated that during the year ending February 1, 1880, the amount of iron consumed in the mill was 21¼ pounds per ton of ore treated. This included the iron of battery shoes and dies, pan-shoes and dies, mullers, sleeves, retorts, etc.

LABOR.—The regular mill force for twenty-four hours is as follows:

TABLE CXIV.—FORCE EMPLOYED AT THE ONTARIO MILL.

Class.	Number employed.	Length of shift hours.	Wages per shift.	Class.	Number employed.	Length of shift hours.	Wages per shift.
Foreman	1			Engineers	2	12	$4 00
Chief engineer	1			Firemen	2	12	3 50
Assayer	1			Salt feeders	2	12	4 00
Clerk	1			Watchmen	2	12	3 00
Night boss	1	12	$4 50	Carpenters	3	10	3 00 to 4 00
Ore weigher	1	10	4 00	Machinists	2	10	4 00
Rock-breaker	1	10	3 00	Machinists' helpers	2	10	3 00
Carmen and drying-furnace feeders	3	12	4 00	Retorter	1	10	4 00
Ore driers	12	8	3 00 and 3 50	Melter	1	10	3 50
Battery feeders	3	8	4 00	Storehouse keeper	1	10	3 75
Amalgamators	4	12	4 50	Blacksmiths	2	10	3 25 and 5 00
Carmen	2	12	4 00	Wood haulers and team	2	10	7 50
Furnace men	6	8	4 00	Assayer's helper	1	10	2 50
Cooling-floor men	12	8	4 00	Tailings-pit man	1	10	3 00

EXPENSES AND RESULTS.—During the census year the operations of the mill showed the following figures:

Amount paid on labor account		$127,404 61
Amount paid for mill supplies		$151 537 78
Amount paid for repairs and construction		$65,580 00
Gross ore worked in year	tons	13,858
Net ore worked in year (estimated)	do	11,481
Total number of days in operation		293
Total bullion product in year		$1,344,723 73
Total discount on bullion		$171,241 60

During the company's fiscal year, from February 1, 1879, to February 1, 1880, 15,372 gross or 12,342⅝ net tons were treated. The average assay value of the ore was $130 94, and the average tailings assay was $17 49. The percentage extracted was 88. The bullion product for that period was $1,425,003. At the time of examination, however, battery samples for 10 days averaged $149 65, and tailings samples for the same time $11 12.

The cost of milling ore is $11 69, or $15 including hauling, superintendence, etc. Supplies cost: Coal, $8 25 and salt $8 per ton; wood, $4 per cord.

THE HOMESTAKE 80- AND 120-STAMP GOLD MILLS.

The two large mills of the Homestake Mining Company, at Lead City, in the Black hills of Dakota, are examples of the economy and simplicity to which the treatment of free-gold ores on an extensive scale has been brought. The 80-stamp mill, known as the "Homestake", was completed in July, 1878, at a cost of $164,500. The 120-stamp, or "Golden Star", mill cost $251,500, and was finished in September, 1879. Both mills are situated immediately at the mine. The process is wet-crushing, battery amalgamation, and amalgamation upon outside plates. The capacity of the larger mill is rated at 325 tons per twenty-four hours, and that of the 80-stamp mill at 225 tons.

PLANT.—The 80-stamp mill contains the following machinery: Four Blake improved No. 5 rock-breakers; sixteen Hendy self-feeders; eighty 750-pound stamps, in batteries of five each, drop 8½ inches, 84 per minute, falling in the order 1—4—2—5—3; one clean-up pan; one No. 5 Knowles steam pump, one 20½- by 40-inch engine, 190 horse-power; two 16-foot horizontal boilers.

The 120-stamp mill has six Blake improved No. 5 rock-breakers; twenty-four Hendy self-feeders; one hundred and twenty 750-pound stamps, in batteries of five each, drop 8½ inches, speed 82 per minute, falling in the same order as in the other mill; one clean-up pan; one Knowles No. 5 steam pump; one 26- by 60-inch engine, 300 horse-power; four 16-foot horizontal boilers.

The batteries of these mills are arranged back to back, with space for the feeders between, the discharge being in opposite directions.

LABOR.—The force employed in these mills is very small, the process being very simple and the operations as nearly automatic throughout as it is possible to make them. The regular mill staff is four. The pay-rolls are as follows:

TABLE CXV.—FORCE EMPLOYED AT THE HOMESTAKE 80-STAMP MILL.

Class.	Number employed.	Length of shift.	Wages per shift.
		Hours.	
Amalgamators	5	12	$4 00
Carpenter	1	12	3 00
Day laborers	9	12	3 00
Engineers	2	12	4 00
Feeders	2	12	3 50
Foremen	2	12	4 00
Machinist	1	12	4 00
Watchman	1	12	3 50

TABLE CXVI.—FORCE EMPLOYED AT THE GOLDEN STAR 120-STAMP MILL.

Class.	Number employed.	Length of shift.	Wages per shift.
		Hours.	
Amalgamators	5	12	$4 00
Day laborers	11	12	3 00
Engineers	2	12	4 00
Feeders	2	12	3 50
Foremen	2	12	4 00
Machinist	1	12	3 75
Millwright	1	12	4 00
Watchman	1	12	3 50

COST OF MILLING.—These mills had, up to August, 1880, crushed 275,282 tons, and the total gross product to that date was $1,924,769 52. The mine account during this period showed an average cost of $1 32 per ton, and incidental expenses amounted to 78 cents per ton. The expense of milling is shown in the following table:

TABLE CXVII.—COST OF TREATMENT AT THE HOMESTAKE MILLS.

Items.	80-STAMP MILL (153,372 tons treated).		120-STAMP MILL (121,910 tons treated).	
	Cost per ton.	Amount expended.	Cost per ton.	Amount expended.
Total	$1 30.18	$199,661 01	$0 77.70	$94,728 48
Labor	0 53.36	81,837 72	0 33.17	40,433 75
Supplies	0 10.26	15,887 88	0 02.41	2,933 75
Water	0 11.66	17,874 22	0 10.29	12,548 51
Wood	0 27.88	42,759 35	0 24.76	30,186 03
Machinery	0 16.20	24,847 88	0 03.26	3,977 20
Candles	0 00.77	1,185 75	0 00.13	152 70
Oil	0 02.42	3,721 00	0 01.09	1,323 75
Quicksilver	0 01.79	2,751 71	0 01.19	1,455 00
Teams	0 02.15	3,295 00	.....	.....
Coal	0 01.79	2,742 20	.....	.....
Lumber	0 01.54	2,361 16	0 01.33	1,621 39
Timber	0 00.26	397 14	0 00.07	84 40

Concerning the working of these mills Superintendent McMaster writes:

The gold contained in the ore is mostly coarse, and is easily saved in the batteries. The ore is in the highest degree free milling; even that from the lower levels with several per cent. of iron pyrites is readily amalgamated, the concentrated sulphurets from the tailings showing but $8 per ton. The average loss of gold while working ore containing from $8 to $10 per ton is but $2, as proved by fire assays of the tailings, indicating a yield of 75 to 80 per cent. During the year ending September 1, 1880, both mills had been kept continuously at work, stopping only to clean up on the first and fifteenth of each month. They are in good condition and repair, and the result of their work is in every way highly satisfactory. The amount of ore crushed per stamp in twenty-four hours has been increased by improved working to 3 tons. The quantity milled per month subsequent to the census year averaged 16,700 tons, while previously 2 tons per stamp, or 12,000 tons per month, was regarded as good work.

The average gross yield of the ore to June, 1879, was $9 69 per ton. Since then it was found advantageous to extract and mill all the rock between the walls of the vein. This lowered the grade of the ore somewhat, but the gross amount milled has been increased in greater proportion, while the cost of mining has been correspondingly reduced. The yield of ore from September, 1879, to February, 1880, varied from $4 25 to $5 60 per ton. Since that date it has been increased by the ore of higher grade extracted from the 100-foot level, and now averages $7 95 per ton.

Blankets and concentrating machinery are not employed, as on careful examination and experiment their use was found unnecessary, the pulp being easily amalgamated in the batteries and in passing over the plates. The most perfectly concentrated tailings will not assay per ton more than the rock from which they are derived. The loss of quicksilver in working is very small, being sixteen one-hundredths of an ounce per ton of ore milled, at present prices equivalent to half a cent per ton. The increased capacity of the mills has been aided by improved automatic machinery, reducing the cost of milling to 90 cents per ton in the 80-stamp mill and 71 cents per ton in the 120-stamp mill. The mills are run by steam. Firewood is delivered at $4 75 per cord. The cost of fuel is 28 cents to the ton of ore crushed. Water is purchased for the mills from the Black Hills Canal and Water Company at the rate of $2 per stamp per week. Forty miner's inches are required. The cost is 11 cents per ton of ore crushed. The water company obtain an abundant supply from the head of Whitewood creek, a distance of 10 miles. The average fineness of the bullion in the first year's working of ore from the open cuts on the surface was 0.825 gold, 0.165 silver, and the value per ounce $17 25; at the close of the census year the average fineness was 0.800 gold, 0.170 silver, and the value per ounce $16 75, most of the ore coming from the 100-foot level.

ARRASTRAS.

The arrastra is a simple and effective device for reducing ores, the legacy of the primitive but much underrated mining system of Mexico. Notwithstanding the slowness of its operation, it has not been entirely supplanted by the stamp- and pan-mill, and still has a large field of usefulness. The arrastra is the prototype of the amalgamating pan; indeed, it combines to a certain extent in a single apparatus the functions of stamps, pan, and settler. The leading advantages of the arrastra are: simplicity of construction and cheapness of first cost, thus placing it within the means of mine owners having but small capital and enabling it to be used during the period of development of mines, economy in working, and effectiveness in saving the precious metals of ores adapted to it when judiciously managed. Its disadvantages are the relatively small quantity of ore which can be treated in a given time and the fact that certain classes of ores are not suited to it, though this latter objection may also be said to apply to any particular type of stamp- and pan-mill.

Arrastras are still largely used in the United States, but of the several hundred scattered through the country a few only were selected for examination. Table CXVIII gives the number of arrastras, number and weight of drags in each, and character of motive power of thirty-two works, in which are employed one hundred and eleven arrastras.

TABLE CXVIII.—SPECIMEN ARRASTRA MILLS.

ALABAMA.

County and district.	Works.	Number of arrastras.	Number of drags.	Weight of drags.	Motive power.
CLEBURNE.				*Pounds.*	
No. 33	Houston & Pinson	1	6	100 to 300 each	8 horse-power engine; also runs battery.

ARIZONA.

MOHAVE.					
Hualapai	Gross & Smith	2	2 each		4 horses.
YAVAPAI.					
Tiger	South Oro Belle	2	4 each	400 each	5 horse-power engine.
Walker	Thunderbolt	4	4 each	175 each	20 horse-power engine.
Weaver No. 2	Johnson	2	4 each	250 each	2 horses.
	Nash	3	6	200 each	1 horse for each arrastra.

CALIFORNIA.

CALAVERAS.					
Angels	Leper, Keys & Co	6	3 each	300 to 500 each	Overshot wheel, 28 feet diameter, 50 inches water.
Do	Potter	2	3 each	300 to 500 each	Overshot wheel, 20 feet diameter, 25 inches water.
Independence	Champion	2	4 each	750 each	Overshot wheel, 40 feet diameter, 50 inches water.
FRESNO.					
Potter Ridge	Fresno Enterprise	3	4 each	800 to 1,000 each.	
PLUMAS.					
	Italian	35	Usually 4 each	500 to 2,000 each.	Hurdy-gurdy wheels.

COLORADO.

BOULDER.					
Colorado	George Bachelder	2	2 each		Water-power.
OURAY.					
Iron Springs	Rock Point	4	6 each	200 each	Turbine.

IDAHO.

BOISÉ.					
Granite	Iowa	1	3	250–600 and 800	40 horse-power engine; runs battery also.
LEMHI.					
Yankee Fork	Estes	1			Leffel turbine, 12½ inches diameter; 65 feet fall.
Do	Norton's	2	4 each	*a* 1,000–1,200 each	Overshot wheel, 15 feet diameter, 5 feet face; 150 inches water.
OWYHEE.					
Carson	Scales & Wagner's	2	4 each	250 to 300 each	In winter, 30 horse-power engine; other 8 months, 20 feet overshot wheel, 4 feet face.
Do	Trask's	2	4 each	300 each	Overshot wheel, 24 feet diameter, 2 feet face.

a When new; used until worn to 250 or 300 pounds.

MONTANA.

DEER LODGE.					
Black Tail	Black Tail	2	4 each	2,000 to 3,000	Water-power.
	Glen Egbert	1	4 each	500 each	Overshot wheel, 14 feet diameter, 2½ feet face.
LEWIS AND CLARKE.					
Ore Fine Gulch	Schafer	2	One 4; one 8	500 each	Overshot wheel, 33 feet diameter.
MADISON.					
Silver Star	H. Siegchrist	2	4 each	800 each	Overshot wheel, 20 feet diameter, using 60 inches water.

NEVADA.

ESMERALDA.					
	E. R. Willis	1	5	120 each	Undershot wheel.
STOREY.					
Gold Hill	B. B. Chandler	1	4	200 to 500 each	Overshot wheel, 24 feet diameter.

TABLE CXVIII.—SPECIMEN ARRASTRA MILLS—Continued.

NEW MEXICO.

County and district.	Works.	Number of arrastras.	Number of drags.	Weight of drags.	Motive power.
				Pounds.	
GRANT.					
Pinos Altos	Skillicorn's	4	4 each	80 each	20 horse-power engine.

NORTH CAROLINA.

NASH.					
Griffith township	Mann	10	4 each	200 to 400 each	40 horse-power engine.

OREGON.

BAKER.					
Chicken Creek	McCord	2	4 each	300 to 500 each	Overshot wheel, 24 feet diameter, 12 horse-power.
GRANT.					
Granite	Beagle	1	6	300 each	Hurdy-gurdy wheel, 10 horse-power.
JOSEPHINE.					
Yank	Sugar Pine	3	4 each	600 each	Water wheel, 20 horse-power.
YAKIMA.					
Peshaston	Cooper & Lockwood	3	6 each	200 each	Turbine, 20 feet diameter, 13 feet fall, 9 horse-power.
Do	Shafer	1	4	500	Horizontal hurdy-gurdy.
Do	Witer & Miller	3	5 each		Hurdy-gurdy, 8 horse-power; and breast wheel, 20 horse-power.

OWNERSHIP.—The greater number of arrastras are owned in connection with small but productive mines. Of those which are owned independent of mining property a few of the larger and best-equipped works are operated as custom mills, while the others are run on tailings. A large number of water-power arrastras are engaged in working over the tailings of the Comstock and other veins. Of the arrastras reported upon nearly all were constructed since 1876. As they are so often built merely as temporary make-shifts, it is natural that their average life should be short. Incorporated companies seldom own arrastra mills.

COST OF PLANT.—The crudest form of arrastra, to be operated by mule-power, can be built for $150. From this the cost of construction ranges upward to $1,000 for a substantial and large apparatus. Other plant is also involved in the better class of arrastra mills, such as the building, engine or wheel, ditches, flumes, pipes, retorts, and when pans, etc., are added, as is sometimes the case, the mill becomes an expensive affair. The cost, complete, of twenty-six mills, having ninety-two arrastras, is reported at $137,590, or an average of $5,292 for each works, and of $1,495 per arrastra, including all other plant. These mills, however, are of better construction than is usual, and their average cost is considerably above that of ordinary arrastras.

CONSTRUCTION.—The arrastra in its simplest form consists of a circular bed of rock from 6 to 10 feet in diameter, with walls of vertical planks, having an upright pivoted post in the center, from which extend two or four fixed horizontal arms. Stone drags, weighing usually from 200 to 1,000 pounds each, are attached by ropes or chains to the extremities of the arms, and are slowly drawn around by the rotation of the latter. The depth is usually between 18 and 30 inches. The pavement and drags are of the hardest rock conveniently obtainable, commonly granite or basalt. Sometimes flinty quartz is used, but a coarse-grained rock which will not become too highly polished is preferable. The pavement is laid with much care, and should be quite solid, so that while the amalgam may collect in the small interstices there should be as little loss as possible through leakage into the ground beneath. Hydraulic cement is sometimes used in setting the bed. The paving is usually 12 inches thick when new.

An improved apparatus, called the Americanized arrastra, has been introduced by Mr. A. B. Paul, of San Francisco. It is a double iron pan, the inner portion provided with a grinding muller similar to that used in common amalgamating pans, while a set of drags travels in the outer circle, which is 14 inches wide and 5 inches below the pan muller. It is run by water- or steam-power, and is driven by bevel gear beneath the arrastra. A revolving amalgamated copper circle acts as do the aprons of gold batteries. The sizes made are 6 and 8½ feet in diameter. The latter size requires 5 horse-power, weighs 4½ tons, and has a capacity of from 7 to 10 tons in twenty-four hours, according to the hardness of the ore and the fineness to which it has been reduced before feeding.

DRAGS.—The number of drags used ranges from two to twelve per arrastra, the most common number being four. There is also a great variation in their weight, the lightest reported being only 80 pounds, and the heaviest one ton, the mean weight, when new, being somewhat above 300 pounds each. The usual speed is from ten to

fourteen revolutions of the arms per minute for power arrastras, the range reported being from four to eighteen. The outer drags in a 10-foot arrastra move at the rate of about 400 feet per minute when the arms make fourteen revolutions, though the average is between 200 and 300 feet per minute. The drags are made of the same rock as that used for the pavement.

LABOR.—One man per shift can take care of two arrastras. Some water-power arrastras working on tailings are so arranged that the only attendance needed is in feeding and discharging them, so that practically the labor required is less than the constant work of one man. The owner often does all the work. Continuous arrastras receive no attention other than that demanded for repairs.

POWER.—The smaller arrastras are worked by a single mule or horse. When water-power is obtainable a small overshot, hurdy-gurdy, or turbine wheel is employed. The larger and more complete arrastra mills, which also include other apparatus, such as rock-breakers or stamps, are driven either by water-power or steam, and sometimes by both, using steam only in months when, because of drought or freezing, water is not available.

CAPACITY.—This varies greatly with the completeness of the plant and the character of the treatment, ranging from less than one ton to two tons per day for arrastras of the simplest pattern. In larger works, where rock-breakers and stamps relieve the arrastra of part of its duty, so that it acts simply as a grinding pan, the capacity is dependent upon the length of time necessary to complete amalgamation. A 12-foot arrastra driven by steam- or water-power, with heavy drags making fifteen revolutions per minute, may dispose of two charges, of 4,000 pounds each, of ore of medium hardness in twenty-four hours if very close working is not demanded, but this appears to be the limit of capacity. The annexed table shows the amount of ore treated during the census year by twenty-two specimen arrastra works, having fifty-three arrastras, few of which, however, were running very constantly. The average per mill was 413.75 tons, and for each arrastra 171.70 tons.

TABLE CXIX.—ORE TREATED BY TWENTY-TWO SPECIMEN ARRASTRA MILLS IN THE CENSUS YEAR.

State or territory.	Number of works.	Number of arrastras.	Tons treated.
Total	22	53	9,101½
Arizona	4	9	186
California	4	13	3,205
Colorado	2	6	284
Idaho	2	4	2,022½
Montana	3	5	2,250
New Mexico	1	4	560
Oregon	6	12	645

TENOR OF ORE TREATED.—Arrastras are usually employed in working free-gold ores, though they also produce doré bullion. Very little ore as low in grade as $10 per ton is reported to have been worked in these mills, the average value being somewhat higher than that of ore treated in pan mills.

PROCESS.—The ore, after having been broken by hand or by a rock-breaker or stamps, is fed into the arrastra, a sufficient quantity of water being added to keep the pulp at the proper consistency. It is not customary to add quicksilver to the charge until it has been ground from two to four hours, but the chemicals, when used, are generally added on charging, though sometimes they are put in with the quicksilver. The quantity of quicksilver used is governed by the contents of the ore. In working gold ores the object is to produce a pasty amalgam rather than a liquid one, while in treating silver ores larger quantities are used, sometimes amounting to more than a pound of quicksilver to the ounce of silver in the ore. As assaying is not often practiced in connection with arrastra mills, the millman judges the tenor of the ore being worked by panning out a sample of the pulp. No chemicals are commonly used with gold ores, though potassium cyanide in solution is sometimes employed to "liven" the quicksilver, and lye or wood ashes is used for the purpose of saponifying any grease which may have found its way into the arrastra. With silver ores bluestone (or copperas) and salt are used, the quantities of each being very indefinitely regulated, as is the case in pan amalgamation. The length of time occupied in working a single charge is usually ten to twelve hours. Toward the close the pulp is thinned by the addition of water, and the speed of the drags is diminished to give the amalgam an opportunity to settle. The arrastra is discharged by withdrawing successive plugs, arranged as in the common settler, or by opening a gate in the side. A clean-up is made after each run on custom ore, and usually once a fortnight if working steadily on the owner's ore.

The arrastra is sometimes used as an adjunct to the gold stamp-mill. At the Iowa mill, in Idaho, and in some works in California, the pulp flows continuously from the battery to a constantly working arrastra, and thence overflows through a gate near the top of the side upon amalgamated copper aprons and sluices. In this continuous process a flask of quicksilver is charged in the arrastra at the beginning of the run.

SCALES & WAGNER'S ARRASTRA MILL, OWYHEE COUNTY, IDAHO.

This mill is selected for description as a typical example of the better class of arrastra works. It is situated on the west bank of the Jordan river, 1 mile south of Silver City, at a distance of from half a mile to 2¾ miles from the mines of Carson district and 10 miles from Wagontown district by road. The mill was originally constructed in 1874 at a cost of $60,000, and was intended to be a 10-stamp wet-crushing silver mill. It was bought by the present owners in February, 1877, and considerably improved, though a part of the old machinery had been previously removed. The building is a substantial one, partly of stone with brick facings and partly of wood, and is conveniently arranged.

The mill is designed to treat the richer ores of the district. These are of two distinct classes—a free-gold ore, and a silver ore of which the principal mineral is probably argentite, also containing gold. The gangue is a moderately friable quartz.

The plant consists of a light 10-stamp battery, two arrastras, three half-ton Wheeler pans, two settlers, and a retort. Power is furnished during eight months of the year by a 20-foot overshot wheel with 4-foot face, and in winter by a 30 horse-power horizontal engine.

The stamps are used in place of a rock-breaker, to prepare the ore for the arrastras, and thus save wear and time in grinding. Dry-crushing is employed. The mortars are open in front, without screens, and the ore is delivered in variable fineness, ranging from dust to pieces as large as hazel-nuts. One battery of five stamps, running four hours a day, usually supplies sufficient ore to keep the arrastras working.

The arrastras are on a floor immediately in front of and below the battery. They are driven by a bevel-crown wheel from the counter-shaft, and power is communicated to the latter by a belt and pulley. The inside diameter is 10 feet. The paving and drags are a very hard, flinty quartz, obtained from a barren ledge about 1 mile south of the mill. Each arrastra has four drags, weighing from 250 to 300 pounds apiece. The speed is from twelve to fifteen revolutions per minute. A charge weighs 800 pounds dry, and the length of time occupied in working in the arrastra is ordinarily six hours, though with very rich rock the time is extended to eight hours. Four and a half hours after charging, when working gold or doré ores, the quicksilver is added, the proportion being determined by the assay of the ore. With silver ores the amalgamation is performed in the pans, the arrastras then being used merely for grinding. The average amount of quicksilver used is 125 pounds per charge, though with the highest grade of ore this is increased to 200 pounds. With gold ores a little lye is sometimes added. The treatment of silver ores in the pans is essentially the Washoe process, bluestone and salt being used in quantities ranging from 1 ounce to 2 pounds of the former and from 5 to 20 pounds of the latter, depending on the tenor of the ore. Both salt and bluestone are added on charging and in the dry state.

The arrastras are discharged by a plug-gate in the side, and the pulp flows directly into the pans through a wooden spout. Treatment in the pans and settlers is similar to that ordinarily followed in pan mills. A clean-up is made after working each custom lot, and these parcels of ore are sometimes very small, amounting occasionally only to a half a ton or so at a time of carefully-sorted $500 or $600 ore. Amalgam is strained by hand through a canvas bag and retorted in a cylindrical retort, 3 feet 6 inches long and 9 inches diameter, having the vent at the center of the rear end. The time occupied in retorting is usually seven hours.

Tailings are worked in the pans by the same process as in the first treatment, with the exception that larger quantities of bluestone are used, ranging from 4 to 5 pounds per charge.

The arrastra pulp is sampled every half hour as a check on the ore assays of customers, and tailings samples are taken from the settler discharge. The percentage of gold extracted by first treatment reaches 90 per cent., and of silver from 75 to 80 per cent.

The force employed in summer is as follows: Inside the mill four men, at $4 each, per twelve-hour shift; outside, two laborers, at $3 50 per ten-hour shift. In winter, when steam is used, two engineers, at $5 each per twelve-hour shift, are added to the force. During the census year the mill ran 330 days, and 22,440 hours' work were done. To treat a ton of ore required twelve and seven-tenths hours' labor (calculated as if done by one man). When in operation the mill runs full time.

As the mill works on high-grade ore, the process is necessarily an expensive one. The average cost of supplies during the census year, as will be seen from the accompanying analysis, was $3 95 per ton of ore treated. In this respect the operations of this mill are to be considered as representative not of the average practice, but of the best.

TABLE CXX.—SUPPLIES CONSUMED IN SCALES & WAGNER'S ARRASTRA MILL DURING THE CENSUS YEAR.

Items.	TOTAL CONSUMPTION.		CONSUMPTION PER TON TREATED.	
	Amount.	Cost.	Amount.	Cost.
Total	.....	$7,018 75	.....	$3 95
Red fir ..... cords.	575	4,168 75	0.32	2 35
Quicksilver ..... pounds.	3,000	1,440 00	1.69	81
Salt ..... do...	14,000	420 00	7.89	24
Bluestone ..... do...	3,000	750 00	1.69	42
Lard-oil ..... gallons.	20	40 00	0.01	02
Chemicals and sundries	.....	200 00	.....	11

During the census year the mill treated 1,772½ tons, of which less than 300 tons were tailings. The lowest yield of ore per ton was $38, the highest $600, and the average $115 85. The tailings treated yielded about $9 50 per ton. The total product was $205,331 75.

The custom charge at this mill is $15 per ton for lots of 100 tons and over, $16 for lots of from 50 to 100 tons, and higher rates for very small parcels.

CHAPTER VI.—LEAD SMELTING AT LEADVILLE, COLORADO.

BY S. F. EMMONS.

PLANT.

INTRODUCTORY.—Although a very large amount of technical data on the various smelting works of the West was collected by the census experts, they were not found sufficiently complete to serve as the sole basis for a detailed description of the processes employed; nor do these works in general, as far as they are open to public inspection, present any features which are unusual or new to metallurgical science. At Leadville, however, where the numerous smelting establishments produce annually about $15,000,000 worth of argentiferous lead bullion, metallurgists have necessarily acquired an unusual amount of practical experience in the conduct of the operations of lead smelting and in the management of the business connected therewith. It has therefore been judged expedient to present a succinct account of the natural and economical conditions of smelting at this point, of the character of the plant, and of the processes employed. For this purpose recourse has been had to the MS. of a report by Mr. A. Guyard on the lead smelting of Leadville, which is to appear as an appendix to a monograph on the geology and mining industry of that district. An abstract of this report has been made by Mr. W. F. Hillebrand, and is supplemented by data obtained from census material and by himself and the writer personally, which appears in the following pages. In this the chemical investigations and calculations made by Mr. Guyard have been freely used, and the two illustrations which accompany it are taken from his plates; but all discussion as to the fitness or unfitness of methods employed, or of theoretical questions arising therefrom, has been avoided.

TOPOGRAPHICAL CONDITIONS.—An important condition in the disposition of smelting works, as well as of quartz-mills and other reduction works, is that the force of gravity may be used as an aid in handling the material to be treated, which is generally of a heavy and bulky nature. To such a disposition the surface character of the Leadville region is admirably suited by nature. The town itself is situated on a gently sloping mesa included between Evans gulch on the north and California gulch on the south, at the western base of the foot-hills of the Mosquito range, in which its ores occur. Along the high banks, which rise from the bottom of either of these gulches to the comparatively flat surface of the mesa, and at a sufficient elevation to allow room for the slag dumps below them, are located the various smelting works. They are thus situated so that from the mines an equally favorable grade leads either to the upper or the lower portion of the works, and the railroad which follows the surface of the mesa sends its branches on the level of or above the charging floor, and thus delivers its freight of fuel or of ore where it may descend through the various stages of the process until the final product, the bars of bullion, is obtained.

DISPOSITION OF THE PLANT.—No less than sixteen smelting works have been built at Leadville in the few years that have elapsed since its mines were opened. Of these, however, a number have been closed, some temporarily, others permanently. The general plan in these works is that adopted elsewhere, and involves the occupation of two principal floors. The lower of these floors is at such a height above the adjoining valley bottom as to afford a convenient opportunity for dumping slag and other waste. On this floor the furnaces are built, and room is also commonly provided for the blower and the engine by which it is actuated. The furnaces are usually placed in a row within a single inclosure, but sometimes they have a wall intervening between them. The upper floor is on a level with the feeding-door of the furnaces, from 12 to 14 feet above the lower, and affords space for ore-bins, fluxes, mixing-beds, and the operations connected with charging the furnaces, such as crushing and sampling. When the slope of the ground is great, however, the storage bins for ore and fuel are sometimes placed at a still higher level, with passages for wagons between. One roof generally covers the whole establishment, with the exception of the offices, laboratory, and scales, which commonly occupy detached buildings.

FURNACES.—Shaft furnaces only are employed in Leadville. Of these two varieties were in use during the census year, the one presenting a circular horizontal cross-section, sometimes called the Piltz furnace, while the other is rectangular; but in 1882 the latter had entirely replaced the former. While the circular section presents advantages in the regularity of the descent of the charges, it is more expensive in construction, and the diameter of the hearth is limited by the strength of the blast; indeed, with any ordinary blowing-engine a round furnace can be successfully worked only when it is of very moderate dimensions. The rectangular or Raschette furnace, on the other hand, may be constructed with a width at the tuyeres corresponding to the strength of the blast-engines, and the production may be increased by increasing the length of the cross-section. The horizontal elongation of the furnace has its limits, indeed, as has been proved by the history of the rectangular Raschette furnaces in Europe, but the capacity may nevertheless be increased considerably above that of a circular furnace of similar construction without deleterious effects upon the working. In lead smelting, and especially in smelting argentiferous lead ores,

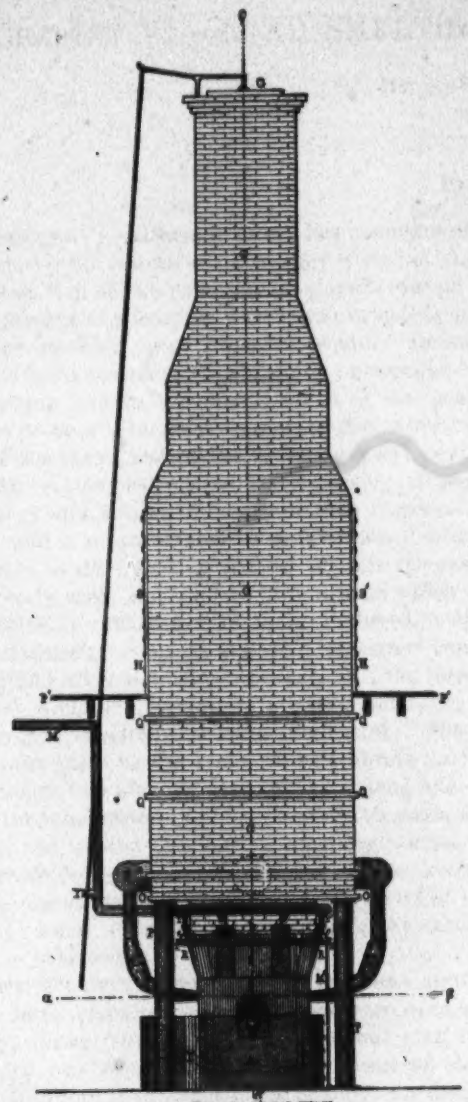


Fig. 1. ELEVATION

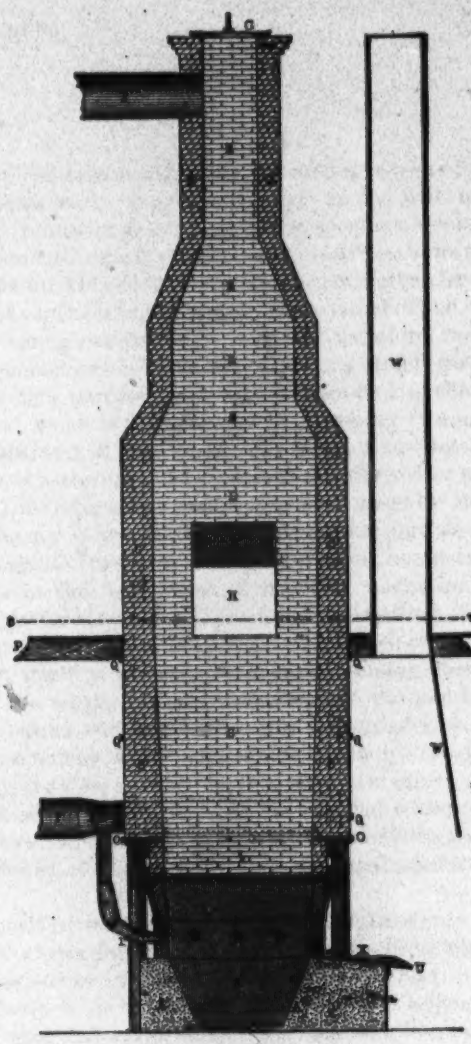


Fig. 3. SECTION ON $\gamma\delta$

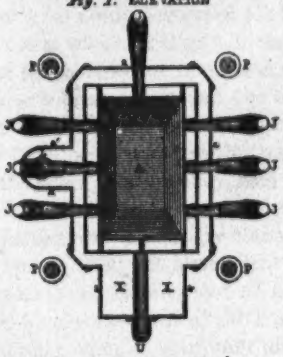


Fig. 2. SECTION ON $\alpha\beta$

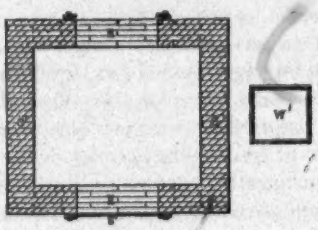


Fig. 4. SECTION ON $\varepsilon\zeta$

M Rice Del.

RECTANGULAR FURNACE

it is very undesirable to employ the high-pressure blasts required by a circular furnace of large diameter, since the higher temperatures which result promote the production of fumes which are only imperfectly recovered and are always difficult of treatment.

The rectangular and the round furnaces of Leadville are constructed on the same general plan so far as height, method of support, water-jackets, tuyeres, etc., are concerned, but the sizes adopted vary greatly, the limits of capacity being from 15 to 40 tons in twenty-four hours.

Plate I, Fig. 1, represents a rectangular furnace in elevation drawn to a scale of 6 feet to the inch, and Fig. 2 the same furnace in horizontal section at the tuyere level. Fig. 3 shows a vertical section of the same furnace on its longer diameter, and Fig. 4 a horizontal section at the charging-doors. The masonry shaft (*C*) rests upon a cast-iron plate (*O*), supported by pillars (*P*), in order that there may be no unnecessary weight on the lower portion of the furnace. The walls for some distance above and below the tuyeres are formed of sectional water-jackets (*B*), constructed of cast or wrought iron or of steel. In the furnace illustrated the water-jackets are twelve in number, firmly bolted together and provided with openings for the insertion of the tuyeres (*N*). A cold-water pipe (*M*) runs around the furnace above the water-jackets, and water is admitted to each of them by a faucet (*Y*). Outlets (*M'*) for the hot water and gutters (*T*) for its removal are also shown in the illustrations. The interval (*b*) between the water-jackets and the plate on which the shaft of the furnace rests is filled with fire-brick, which can be readily removed in case of necessity. The lower ends of the water-jacket rest upon the hearth (*X*). This consists of cast-iron plates (*a*) bolted together and lined with a thick coating of fire-brick or of "steep" (brasque), a mixture of fire-clay and coke-dust, either in equal parts, or in the proportion of two of the former to one of the latter. The usual form of the hearth is shown in the illustrations; this, however, is modified in detail, according to the working of the furnace and the judgment of the manager or smelter, changes in it involving no modification of the iron plates.

The hearth plates include also the lead well *L* and the so-called "siphon tap". A similar device was long ago applied to the small charcoal-iron blast-furnaces of Silesia, to permit of the manufacture of castings without tapping the furnaces; it was not successful, however, the iron chilling too rapidly for the object in view, owing to its high melting point. This arrangement was introduced into lead smelting in Eureka, Nevada, by Mr. Albert Arents with great success, and has since been widely adopted both in this country and abroad. The lead rises through the oblique tap-hole *L'* shown in Fig. 1 to the same level in the well which it occupied in the furnace, and can be baled into the molds at leisure, and without the disturbance of the furnace-working incident to the old method of tapping at long intervals.

At the end of the furnace just above the hearth an opening (*V*) is left in the water-jacket to facilitate the tapping of slag. This opening is filled with clay, in which a hole can be pierced when required, allowing the slag to pass through an inclined gutter (*U*), shown in the illustrations, into a slag-buggy. A hood (*W*) is generally placed over the tapping-hole to draw off the fumes emitted during the tapping. The number of tuyeres varies with the size of the furnace, depending mainly on the length of the cross-section. A tuyere is always placed at the end of the furnace opposite the slag-tap, and sometimes also above it; this last, however, is somewhat in the way, and is often omitted. A sliding valve (*l*) at the elbow of the nozzle admits of the inspection of the interior of the furnace. The tuyeres are connected with the main blast-pipe (*I*) by canvas hose (*K*), the flexibility of which permits their withdrawal from the furnace when necessary. This convenient device is, of course, applicable only when cold air is supplied to the furnace, as is almost invariably the case in lead smelting. Feed-openings (*H*) on the upper floor are closed by sliding doors (*S*). The furnace terminates upward in a short chimney (*E*) and may, in case of need, be run without the dust-chambers, with which it is connected by a flue (*F*) indicated in the illustration.

As an example of recent construction, the furnaces in the works of Eddy, James & Grant, at Denver, may be cited. There are eight of these furnaces of the same pattern, all built in the spring of 1882. The height to the charging-door is 18 feet; the dimensions 3 feet below the charging-door are 60 by 102 inches; at the top of the jackets, 48 by 92½ inches, and at the tuyere level, 36 by 80½ inches. Each furnace has ten tuyeres, four on each side and one at each end. The capacity of each is about 30 tons. The waste gases and fumes are drawn from all these furnaces at a point below the charging-doors into large dust-chambers connecting with a single stack—a very convenient arrangement so far as the comfort of the workmen is concerned; whether it is accompanied by any ill effect upon the working of the ore is regarded as uncertain, but each furnace is provided with an independent stack, to be used in the event of its proving desirable to return to the ordinary practice.

Plate II shows a furnace with a circular horizontal section on the same scale as the rectangular furnace illustrated on Plate I, and a comparison will show that the general principles governing the construction are the same in both. A main point of difference is in the anchoring, which in the square furnace is necessarily effected by bars (*Q*), while the same object is more conveniently attained, when the section is circular, by a shell of sheet iron (*J*) composed of plates about a quarter of an inch in thickness. The diameter of round furnaces at the tuyere level is from 33 to 48 inches, and the capacity varies with this dimension.

DUST-CHAMBERS.—The appliances for catching flue-dust in the Leadville smelting works are generally very imperfect, but the reproach does not apply to Leadville alone, for, however extensive the system employed elsewhere, it fails to accomplish its purpose completely. It is said that some English lead works have dust-chambers no less than 5 miles in length, and yet fail to recover all the dust carried from the furnaces; some of the Leadville works, however, make no attempt to collect the flue-dust, a practice unworthy of imitation. The ordinary provision

consists of brick chambers on or below the charging-floor, either divided into sections by walls and curtains or not. One such chamber is 75 feet long, 25 feet wide, and 15 feet in height, and another of the same length is only 4 feet wide and 6 feet high. The dust-chambers are sometimes built of iron instead of brick, and the circuitous direction given to the current by the interposition of walls and curtains in brick chambers is then often obtained by the use of adjoining vertical cylinders, the air and fumes entering the bottom of one and the top of the next.

BLAST-ENGINES.—The blowing engines employed are most commonly of the Baker rotary pattern, though at one establishment the Root blower is in use. The pressure of the blast furnished by these blowers varies from half an inch to 1½ inches of mercury, or say from one-fourth to three-fourths of a pound per square inch, the most usual tension being 1 inch of mercury, or about half a pound per square inch. Where several blowers are employed in furnishing blasts to more than one furnace the pressure is equalized, and the probability of an interference with the work through the stoppage of a blower is decreased by connecting them all with the same main blast-pipe.

The iron work of the furnaces is sometimes made by Denver firms, but usually the entire plant is ordered from the East.

BARTLETT FILTER.—An experiment was made at one of the works with this arrangement for collecting flue-dust which gave some interesting results. The following is condensed from Mr. Guyard's description:

The stack of one of the square furnaces was connected with a Sturtevant fan by means of a sheet-iron flue, through which the fumes were drawn from the furnace and blown through a sheet-iron pipe 150 feet in length, which was connected, by means of two branch pipes, with two boxes of thin sheet iron. The dust was collected in the sheet-iron pipe as in an ordinary flue. Each branch pipe was provided with a damper, or valve, similar to those used in stovepipes, so that the fumes could be distributed to one or both of the boxes at pleasure. Each box consisted of a dust-chamber and a fireplace, the former being provided with sliding doors, placed at either extremity, and the fireplace with doors in front and sheet-iron pipes at the back, communicating with a stack. At the top of each of the dust-chambers were twenty-eight apertures, to each of which was fastened a cloth bag, 30 feet high, suspended to the beams of a light wooden structure, in which the apparatus was inclosed, and which was provided with very large openings for ventilation. When the apparatus is at work the fumes blown in distribute themselves in the dust-chambers and ascend the cloth bags, through which they are filtered. The gases come out perfectly colorless and free from any lead dust or even soot. The wind entering freely through the apertures of the building shakes the bags, and the dust with which they are charged falls back into the dust-chambers. When a sufficient quantity of this dust has been accumulated, the doors connecting with the fireplace are opened and a light wood fire is kindled. The soot soon catches fire and burns off, leaving the dust white. During a run of five days 3,030 pounds of calcined dust were caught in a Bartlett filter from one furnace. The experiment was not entirely satisfactory, owing to defects in the manner in which it was carried out; but the defect was one of arrangement, and by no means inherent in the filter. The furnace was worked without closing the feed-hole, as with an ordinary dust-chamber. The Sturtevant fan consequently drew in as much air as smoke, so that the chamber of the furnace had to be left half open, and about half the smoke escaped directly into the open air. The use of this arrangement was abandoned by the owners of the works partly on account of the expense involved and partly, as stated by them, on account of the large percentage of arsenic (15 to 20 per cent.) in the condensed matter and its low tenor in silver. As Mr. Guyard, in his analysis of this substance, found extremely little arsenic and much lead, chiefly combined with phosphoric acid, chlorine, and bromine, it is difficult to imagine on what ground the presence of arsenic in such quantity could be inferred. Mr. Guyard's analysis is supported by the fact that arsenic is present to but small extent throughout the district, while phosphoric acid exists in large quantities in many of the ores.

RAW MATERIAL.

ORES.—The ores of Leadville are remarkably pure argentiferous lead ores. They are locally divided into two general classes: the "sand carbonates", which are loose, sandy masses of carbonate of lead with chloride of silver, and the "hard carbonates", which are masses of porous siliceous material with a varying proportion of hydrated oxides of iron and manganese, carrying carbonates of lead and chlorides of silver, and sometimes containing a considerable proportion of unaltered argentiferous galena. As a rule, with the exception of mechanical mixtures of clay and varying proportions of iron and silica, they contain but few foreign ingredients. Intimately associated with the carbonates is generally a little pyromorphite or chloro-phosphate of lead, amounting in one exceptional case to 10 and in another to 30 per cent. of the whole. Sulphate of lead also occurs in small quantity, with small and variable amounts of oxidized compounds of copper, arsenic, antimony, and manganese. The latter is often abundant, and is associated with or replaces iron oxide. Ores which are rich in manganese are generally poor in silver. The galena is frequently covered by a coating of carbonate showing clearly the alteration of the sulphide, first to sulphate, and then to carbonate. In some few mines bismuth and vanadium ores have been found. But a small proportion of the ores smelted is furnished by districts outside of Leadville. Of this the greater part comes from Ten-Mile district, in Summit county, and especially from the Robinson mine, whose deposits carry much pyrite and zincblende. The silver in the oxidized ores is present in combination with chlorine, bromine, and iodine, either as chloride, chloro-bromide, or chloro-bromo-iodide, as the analyses on page 289 of specimens from several mines made in the laboratory of the United States geological survey at Denver show.

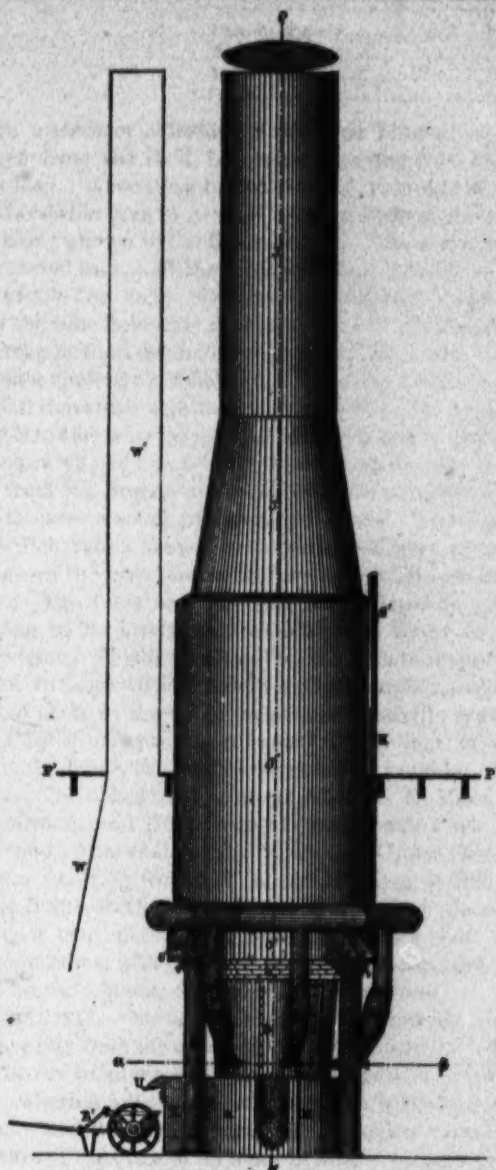


Fig. 1. ELEVATION

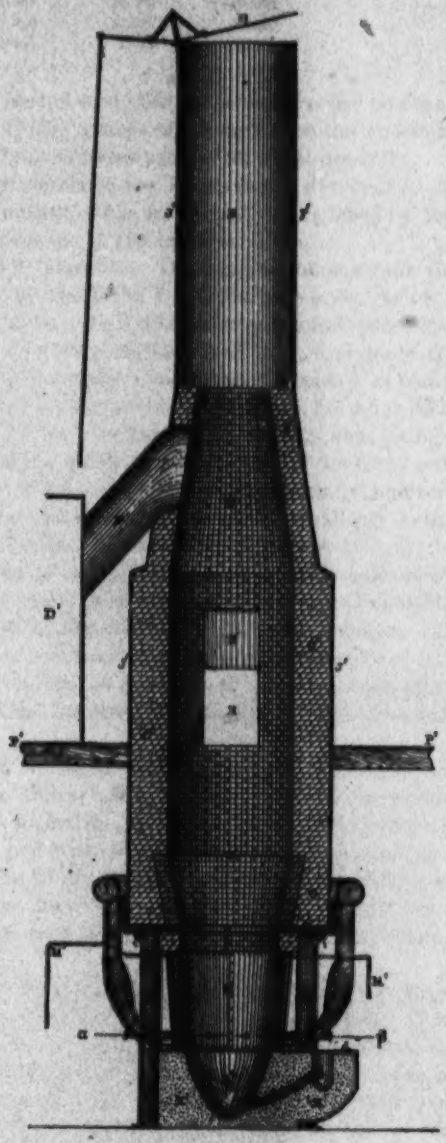


Fig. 3 SECTION ON $\gamma\delta$

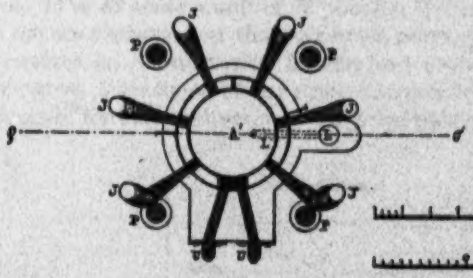
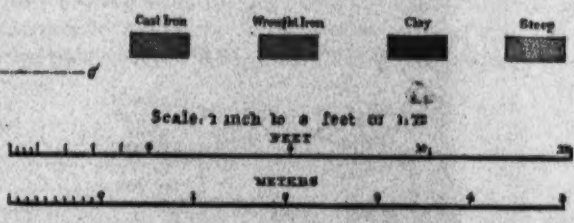


Fig. 2. SECTION ON $\alpha\beta$.



CIRCULAR FURNACE

	R. E. Lee mine.	Amie mine.	Big Pittsburgh mine.
Chloride of silver	31.589	15.785	66.865
Bromide of silver	77.869	84.082	None.
Iodide of silver	0.428	0.134	0.085

Large masses of chloride of silver, or horn-silver, have been found, and on several occasions tons of ore have been taken from the R. E. Lee mine assaying from 8,000 to 15,000 ounces of silver to the ton and almost entirely free from lead. According to Mr. Guyard, sulphide of silver is sometimes present in small quantity.

The Leadville ores in general contain little or no gold, its presence not being easily detected in the ore itself, but only being shown in the final product. The average daily output of the mines in 1880 is placed by Mr. Guyard at from 700 to 800 tons, and the total smelting capacity of the furnaces at 700 tons per diem.

FLUXES.—The fluxes used in Leadville are limestone and hematite. During the census year the limestone used was the blue dolomitic limestone (Lower Carboniferous), in which the Leadville ores occur, taken either from open quarries or from dead-work in some of the mines. In the latter case it often carried a small percentage of silver. Experiments showed that dolomite was a less favorable flux than pure carbonate of lime, and since the advent of the railroad limestone has been obtained from the beds of the Colorado Cretaceous formation at Cañon City, 117 miles distant, and more recently still from a bed in the Upper Coal Measures at Robinson, 16 miles distant by rail, where it costs $3 per ton f. o. b. Red hematite iron ore was at first exclusively used as a flux, being principally obtained from the Breece iron mine, where it occurs in large masses between the White and the Gray porphyry, and it is said to carry a small percentage of silver. More recently it has been the practice in many smelters to use the limonite which had collected on the dumps of the various mines, and which also carries a small percentage of silver. In many cases the ores themselves are so ferruginous that but little additional iron is required.

FUEL.—The fuels used are coke and charcoal. Previous to the advent of the railroad coke was scarce and dear, having to be brought 30 to 150 miles by ox or mule teams; hence charcoal was much more largely used than at present. This is furnished by the forests of spruce covering the neighboring mountain slopes. The charcoal produced from these woods varies greatly in quality, according to whether it has been burned in pits or in kilns. The pit-charcoal made in the neighborhood of Leadville is said to contain 2.5 per cent. of ash; a sample of kiln charcoal was found by Mr. Guyard to contain 1.62 per cent. of ash. One hundred and forty-two and one-half bushels of charcoal make 1 ton, the bushel weighing 14 pounds.

COKE.—The cokes used are brought from El Moro, in the southern part of the state, by the Denver and Rio Grande railroad, and from Como, in the South Park, by the Denver, South Park, and Pacific railroad. These cokes are made from coals of the Lignitic or Upper Cretaceous formation, and contain, according to determinations made at the smelting works of Messrs. Billings & Eilers, 22 per cent. of ash for the El Moro and 9½ per cent. of ash for the South Park coke. The composition of the ash of the El Moro coke is represented as being 84½ per cent. silica, 7.1 per cent. peroxide of iron, and 8.4 per cent. alumina, lime, etc. The ash of the South Park coke shows 29.1 per cent. silica, 47.8 per cent. peroxide of iron, and 23.1 per cent. alumina, lime, etc. About 40 pounds of coke make one bushel; hence, 50 bushels make one ton.

ORE BUYING.—Ore is purchased either directly from the mines themselves for cash or from sampling works, which either buy from the mines or act as their agents. Various considerations affect the price paid. From the assay value of the ore in silver a certain percentage is deducted for loss in smelting, which varies according to the nature of the ore, whether siliceous, ferruginous, or sulphureted, or according to a special arrangement made between the mine owners and the smelter owners. A further variable charge is made for cost of treatment, which is dependent on the nature of the ore and its tenor in lead. As a general rule, in regard to oxidized ores, the charge for treatment is lower the larger the percentage of lead they contain. When this tenor is between 5 and 30 per cent. the lead is paid for at from 15 to 45 cents a unit of 20 pounds; the higher the percentage of lead the higher the price paid per unit. When the ore contains less than a certain percentage of lead, which varies with the quality of the ore, the mine owner receives no remuneration for the lead contained in his ore, however rich it may be in silver. The following table gives a specimen of the rates charged for treatment of the ores of some of the best-known mines, the deduction made for loss of silver, and the price paid for each unit of lead above this certain percentage:

Name of mine.	Deduction for loss of silver in smelting.	Cost of treatment per ton of ore.	Price of lead per unit of 20 pounds.
	Per cent.		
Amie	10	$25	$0 35
Chrysolite	5	20	25
Dunkin	5	22	25
Carbonate	7½	20	25
Evening Star	7½	25	25
Morning Star	5	15	30
Iron	5	18	30
Tucson	5	21	25

These figures vary from month to month unless a time contract has been entered into, and are governed by the market quotations of silver and lead at New York and the prices of coke, charcoal, and fluxes at Leadville. Gold, when present in excess of one-tenth of an ounce to the ton, is paid for at the rate of $18 per ounce. The transportation of ore from the mines to the sampling or smelting works is paid for by the smelters at the rate of $1 to $1 85 per ton.

SAMPLING.—When the ore arrives at the sampling works, it is weighed in the wagon on scales generally occupying a detached building. It is then thrown into bins or piles in the open yard, every tenth shovelful as a rule being put into a wheelbarrow. The sample thus obtained is spread out on the sampling floor, and in the case of a sand ore is worked up directly to obtain a thorough mixture. Hard ores are first passed through Cornish rolls. When the ore is thoroughly mixed, it is repeatedly quartered till a sample convenient for drying has been obtained. After drying it is further crushed, mixed, and quartered, and a portion is then ground on the bucking plate by the bucker (*a*) until it passes through a sieve of 70 to 80 meshes to the linear inch. The sample is then divided into three portions, one of which is assayed at the smelter, and a second at the mine or by a public assayer who may be employed by the mine. If the results of the two assays agree closely, a mean is generally taken as the true value of the load; otherwise the third portion is sent for control to a third independent assayer. Sand ores require no crushing before charging into the furnace. For hard ores, slags, fluxes, etc., Blake, and occasionally Alden crushers, driven by steam-power, are employed.

SMELTING CHARGES.—The construction of ore-beds is carried on to a considerable extent at both smelting and sampling works. These beds average from 160 to 180 tons each in weight, and contain approximately equal parts (20 to 25 per cent.) of metallic lead, metallic iron, and silica, of which the proportion of lead is subject to the greatest fluctuation. The proportion of silver to lead is 1 ounce to about 6 or 8 pounds. Sulphureted ores are not roasted, but are thrown directly into the furnace, and are mixed in small quantities with the oxidized ores.

The charges vary so greatly in composition at the different smelters that it is hardly possible to give that of an average one. At first the aim seems to have been to produce a normal singulo-silicate slag, but a change has been gradually taking place to slags of a slightly more acid character, containing from 32 to 36 per cent. of silica. At one smelter the aim is said to have been to produce a slag in which the proportion of earthy base to metallic base should be as one to two, or to some even number. The following examples of different charges are taken from Mr. Guyard's report as specimens of their variable character:

	I.		II.		III.		IV.		V.	
ORE:	*Pounds.*		*Pounds.*		*Pounds.*		*Pounds.*		*Pounds.*	
Ore-bed mixture	100		200		123		500		.....	
Unmixed ore	50		300		183		200		645	
Lead scraps	.....		10		.....		.....		.....	
		150		510		306		700		645
FLUX:										
Dolomite	10		50		90		80		62	
Hematite	10		.....		7		170		.....	
Slag	30		150		60		80		80	
		50		200		157		330		142
FUEL:										
Charcoal	15		80		50		95		80	
Coke	20		60		50		65		60	
		35		140		100		160		140
Total weight of charge		235		850		563		1,190		927

The proportions of charcoal and coke in the fuel vary, according to supply and cost and from other considerations, within the limits of three parts of the one to four of the other.

The table on page 291 gives the calculations made by Mr. Guyard from data obtained for the census year in eight of the principal smelting works of Leadville: First, the average proportion of flux to 100 parts of ore; second, the proportion of fuel to 100 parts of ore; third, the proportion of fuel to 100 parts of smelting charge. In the fourth rubric is given the number of tons smelted per twenty-four hours in each of these works. From these data he calculates the relation of actual to nominal smelting capacity as varying from 26 to 80 per cent. Furnace III is regarded as fulfilling most nearly theoretically perfect conditions.

a The bucking plate in ordinary use in assay offices in the West is a cast-iron plate measuring 2 by 1½ feet, with flanges on the long side rising half an inch above the surface; the latter is planed down, but not polished. The bucker or rubber is a rectangular piece of cast iron 7 by 5 inches, and from 1 to 4½ inches thick. On the upper surface is a socket for a long wooden handle, and the lower surface is curved (a portion of a large cylindrical surface) so that, as the operator pushes it to and fro on the plate to pulverize the ore, a slight rocking motion may be given at the same time, which brings the particles under the bucker instead of pushing them before it.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Proportion of flux to 100 parts ore	25.00	38.0	42.0	34.0	28.8	46.0	33.5	31.70
Proportion of fuel to 100 parts ore	45.33	33.0	33.8	18.5	25.0	46.2	25.0	25.54
Proportion of fuel to 100 parts charges	36.00	23.5	23.7	15.0	19.8	31.5	18.5	18.60
Tons of ore smelted per twenty-four hours	28.00	104.0	51.0	11.5	23.0	15.9	69.5	32.50

The proportions obtained by Mr. Guyard as an average for the entire camp during the census year are:

32.83 parts fuel to 100 parts ore.

23.65 parts fuel to 100 parts charges.

He calculates that 88 per cent. of the lead in the ore is extracted as bullion by direct smelting, the remainder going into the slag and escaping up the stack; also that 1½ parts of fuel are required for each unit by weight of bullion produced.

In the following table Mr. Guyard has calculated with regard to the same furnaces shown in the preceding table: First, percentage of lead extracted in smelting in the form of bullion; second, the percentage of silver extracted; third, the average charges for smelting per ton of ore at each establishment; fourth, the cost to the smelter of treating each ton of ore; fifth, the average assay of slags in ounces of silver per ton; sixth, the average assay of flue-dust in ounces of silver per ton:

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Percentage of lead extracted in smelting	85 to 88	86 to 91	88.0	85 to 95	85 to 90	90 to 93	87.0	90.0
Percentage of silver extracted in smelting	100	95 to 97	97.0	88 to 95	95.3	97.0	96.5	97.5
Charges for smelting per ton of ore	$15 to $30	$15 to $30	$15 to $30	$12 to $25	$16 to $30	$15 to $30	$15 to $30	$15 to $30
Cost for smelting per ton of ore	$12 to $18	$18 to $22	$10 to $15	$13 to $16	$15 to $18	$13	$13 68	$15
Average assay of slags in ounces of silver	2	4	0.5	1.5	1.5	1.5	1.5	4.0
Average assay of flue-dust in ounces of silver	36	37	36.0	35.0	35.0	36.0	36.0	37.0

The above table shows only the conditions which obtained during the year ending June 1, 1880. These have been varied since that time by a general reduction of the smelting charges, owing to competition and to the cheapening of supplies, and also by the reduced tenor of the ore in silver. The proportion of sulphureted over oxidized ores will also probably increase as time goes on.

GENERAL SMELTING OPERATIONS.

BLOWING-IN OF FURNACES.—The furnace is first dried by means of a slow charcoal or wood fire, whose temperature increases gradually for several days. When the drying is completed, the fire is allowed to burn out and the furnace left to cool. The crucible is then lined with steep or brasque; tamping, a simple lining of fire-clay, is sometimes put upon the dam, siphon, and siphon-tap. The furnace is then filled to the feed-hole with charcoal, the tuyere-holes, tympstone, and stack-damper being left open to create a draught. The charcoal gradually becomes incandescent to the very throat. When this zone has reached a low red heat the blowing-in begins. The tuyere-holes of the water-jacket, with the exception of from two to four of those nearest the front, are sealed with plugs of clay, and the wind-bags of the corresponding tuyeres are tied up with strings. Tuyeres are inserted in the holes left open; the tympstone is set in, and the blast then turned on at full pressure. A long flame issues from the siphon-tap, and the fire is kept steadily up until the lead-well becomes red hot. The remaining tuyere-holes are then opened and all the tuyeres are set in. The blast is regulated to the normal pressure, and the furnace is now ready for the filling of the crucible.

FILLING OF THE CRUCIBLE.—Bars of bullion kept in reserve for this purpose, in amount varying from 4 to 12 tons, according to capacity, are thrown in at the feed-door with more fuel, the proportion being three bars of bullion (300 pounds) to eight shovels of charcoal, or about 14 per cent. of fuel. From 100 to 150 bushels of charcoal, according to the capacity of the furnace, are consumed during the blowing-in. When molten lead makes its appearance in the lead-well, a few pieces of live charcoal are placed on it to prevent it from cooling, and the furnace is ready for charging.

CHARGING OF THE FURNACE.—Old slags are first of all thrown into the furnace as a test of its temperature, which is not ready until the slag is perfectly fluid. The head smelter or his assistant opens the tap-hole in the tympstone from time to time to observe their degree of fluidity, and the regular charging begins only when they run quite freely. The charges are disposed on the inside of the furnace next to the walls, a depression being left in the center for the fuel. This is the mode of charging generally adopted, but there are variations in the manner of mixing the materials forming the smelting charges. At some of the smelting works fuel is first thrown in, then old slags, above these the fluxes, and then the ore; at others fuel is mixed with the old slags and fluxes with the ores. The mode of proceeding generally adopted, however, is to mix slags, fluxes, and ore together and keep the fuel

separate. At the most successful establishment the method of mixing fuels and old slags on the one hand and fluxes and ore on the other prevails. In either case the distribution of the materials in the furnace is the same; *i. e.*, fuel is thrown in the center and the charge is distributed around it.

TAPPING OF SLAGS.—The tapping of slag commences as soon as the furnace is in regular operation, and occurs generally every fifteen or twenty minutes, although a few works have adopted the method of continuous flow from the tap-hole. The tap-hole is closed by a lump of clay at the end of an iron tapping-rod. The slag is caught directly in a slag-buggy or conical cast-iron pot mounted on wheels, and is either allowed to solidify entirely in the pot and then thrown out and broken up, or it is wheeled to the edge of the slag heap and tipped over so that it runs in a half liquid state down the sides of the dump. A single smelter adopts the plan of allowing the slag to solidify partially in the pot, and of then making holes through the hardened crust and tipping the pot over so that the still molten material runs out, leaving a shell over 2 inches thick. This shell is easily broken up for re-smelting, it having been found that it is a little richer in silver than the center. Slag samples for assay are taken two or three times a day from the stream in the slag gutter, and their specific gravity and contents in lead and silver are determined in the assay office. Any speiss or matte that may be formed is run into the slag-pot with the slag, and is either thrown out with the latter upon the dump, or, after cooling, is detached from the slag and preserved separately. The proportion of speiss and matte at Leadville is generally very small.

LADLING OF BULLION.—As often as necessary the bullion is dipped out of the lead-wells with wrought-iron ladles and poured into cast-iron molds. At a single smelter a different method obtains. The bullion is tapped periodically from an opening in the clay lining of the lead-well into an iron pot mounted on a small stove, in which a light fire is kept burning. From this pot it is ladled into the molds. The advantages of this method are that the surface of the lead in the well is kept covered. The lead is therefore hotter, and the passage into the crucible is more readily cleaned. Moreover, the lead being drawn from below, the surface is free from skimmings, and the bars are smoother and cleaner.

The bars of bullion are then sampled, weighed, and marked. The sampling is done by taking with a scoop-chisel a piece from the top and a piece from the bottom of each bar. The samples from 200 bars, or 10 tons, which constitute a car-load, are sent to the assay office, where they are melted together and cast into a small bar, from which pieces are taken for an assay.

CONTROL OF SMELTING OPERATIONS.—From time to time the siphon-tap has to be cleared by the insertion of a curved iron rod, about 2 inches thick, previously heated to redness at the curved end.

The tuyeres must be watched from the sliding valve, and when dark rings of chilled slag are observed around them they are removed by iron rods inserted through the tuyere, and the temperature is raised by the addition of more fuel or by a reduction in the proportion of charge.

The water-jackets require constant watching, in order that the temperature of the water issuing from them may be kept as nearly as possible at from 50° to 60° C.

The blast also requires constant attention and regulating, the pressure being increased or diminished as the condition of the furnace, determined by observation from the tuyeres, may demand.

If semi-fluid slags or raw ore form accretions, which do not disappear by an increase of the temperature, the blast must be shut off, the tympstone removed, and the hearth cleaned by means of bars and sledges; after which a little fuel is thrown into the hearth, the tympstone is replaced, and the blast is turned on again. At one period ores rich in lead were scarce at Leadville, and the charges generally contained much less than the normal 20 to 25 per cent. of lead. The running of the furnace became, in consequence, a much more difficult matter, and the formation of obstructions of various kinds was of frequent occurrence.

When accretions form on the walls of the shaft, it is necessary to "bar it out" once in twenty-four hours, or once per shift, as the case may be. To accomplish this charging is interrupted until the contents of the furnace descend to the level of the accretion. The blast is then turned off, a long chisel-pointed bar is introduced into the feeding-hole of the furnace, and, being inserted between the accretion and the furnace wall, is struck with sledge-hammers until the accretion is detached, when the blast is turned on again and the charging resumed.

The Leadville furnaces are generally run with a dark top; *i. e.*, the zone at the throat is so dark that no flames issue from it, and only a black smoke is seen ascending the chimney. This appearance is an indication that the furnace is running properly.

SMELTING OF FLUE- AND CHAMBER-DUST.—Flue- and chamber-dust are mixed in general with lime, and the mixture may or may not be molded into bricks. It is then spread over the ore beds, so that a little of the flue-dust enters into the composition of the smelting charges.

BLOWING-OUT OF FURNACE.—This takes place when the furnace needs repairing, or when an accident, interfering with the regular working of the furnace, has occurred. It is done by suspending the charges and continuing the blast until the whole contents of the furnace are molten. The charge soon burns with a bright top, and the furnace emits torrents of heavy white fumes. When the whole charge has reached the level of the tuyeres the furnace is emptied of its fluid contents, first from the tap-hole, then the breast is removed, and the bullion is taken out of the crucible.

LENGTH OF RUN.—The smelting campaigns are seldom less than three weeks, and often reach six, eight, and even thirteen months.

FURNACE PRODUCTS.

BULLION.—The bullion of Leadville is generally very pure, its constituents other than lead and silver, though numerous, being present in very small quantity. The character of these impurities is shown in the following analyses made by Mr. Guyard, I being bullion from the La Plata smelter, II being a mixture of equal parts of bullion from nine different smelters:

	I.	II.
Lead (by difference)	99.0796210	98.492379
Silver	0.6112445	0.793417
Gold	0.0000888	0.000891
Copper	0.0479100	0.071450
Tin	A faint trace.	0.000897
Bismuth	A faint trace.	0.011791
Arsenic	0.0391365	0.219528
Antimony	0.2138940	0.347881
Iron	0.0063000	0.012600
Zinc	0.0016052	0.000232
Cadmium	A faint trace.	A faint trace.
Sulphur	None.	0.048934
	100	100
Ounces of silver to the ton	178.275	231.408
Ounces of gold to the ton	0.026	0.260

The presence of tin in the bullion seems rather singular, inasmuch as it has not been detected in any of the ores or fluxes of Leadville. It has been suggested that it owed its origin to the great number of preserved-fruit cans scattered about the place, some of which may have found their way into the furnace. It is indeed said that these cans were at one time used at one smelter, probably as a precipitant for the lead in the galena. As tin has also been found in other products at different times, it seems hardly probable that this source can be adopted as that from which it is in all cases derived.

The average assay of bullion shipped from Leadville during the early part of the census year was nearly 300 ounces to the ton, but during the month of December, 1880, it had fallen off to less than 200 ounces. Mr. Guyard estimates the average loss of silver in smelting at 4.115 per cent., and of lead at 11.68 per cent., part of which, however, is recovered from the chamber- and flue-dust. The bars of bullion weigh on an average 100 pounds each, 200 bars, or 10 tons, constituting a car-load. They are shipped to eastern refineries, and when sold direct the latter pay the cost of transportation, which varies from $27 to $35 per ton. The price of lead in bullion is subject to great fluctuation, and has varied between $30 and $78 per ton at Leadville, the average price being $60. Payments are made for bullion at New York quotations, deducting for the cost of refining 3 cents per ounce of silver, or sometimes $14 to $15 per ton of bullion. In other cases the charges are 3 ounces of silver and 5 per cent. of lead per ton:

SLAG.—The slags produced at Leadville are in some instances normal singulo-silicates, but in general rather more acid, the object in producing the latter being to insure a smoother run of the furnace, to require less constant watching and to avoid the formation of sows and accretions. They flow freely, and generally possess, when cold, a compact, fine-grained structure, though frequently well crystallized in parts. They are for the most part strongly magnetic; and Mr. Guyard has shown that this property is not due to any magnetic silicate of iron, but to magnetic oxide of iron, he having isolated these substances in a greater or less quantity and in a state of perfect purity from all slags investigated by him. As a means of judging whether the slag is normal in its composition and contains any excess of lead determinations are made daily at a few of the smelters by means of the Jolly spring-balance. Slags from a normal run carry from 2 to 4 per cent. of lead and from 2 to 4 ounces of silver to the ton, though by attention and careful charging these figures are sometimes greatly lowered. On the other hand, they frequently run much higher, both in lead and in silver, owing to the faulty composition of the charges or to careless regulation of the smelting process. Slags from the earlier campaigns of some furnaces have been found to contain as much as 15 to 20 per cent. of lead, and silver in proportion; in view of which it is hardly a matter of wonder that failures were frequent. Slags accidentally rich in silver, and whole slag heaps from some of the works first started are re-smelted with the ores.

MATTES.—Since the sulphide ores occurring in the region are not roasted, but thrown directly into the furnace, mixed in small proportion with the oxidized ores, a certain amount of matte is necessarily formed, which consists mainly of sulphides of iron and lead, with, as ascertained by Mr. Guyard, a large percentage of magnetic oxide of iron. These mattes carry from 40 to 90 ounces of silver to the ton, and are roasted in heaps preparatory to being re smelted.

SPEISS.—Speiss, which is found only in small quantity, is an iron sulph-arsenide, and seems to concentrate in itself all the molybdenum as well as most of the nickel, traces of which exist in the ores. It is further characterized by its very small percentage of antimony, and, according to Mr. Guyard, by the total absence of cobalt. It is a question, however, whether an examination of a large number of samples would justify the conclusion drawn by Mr. Guyard that a complete separation of nickel and cobalt is effected in the smelting process. He found cobalt without nickel in the skimmings from the lead-wells and nickel without cobalt in the speiss.

Its silver contents vary from 2 to 4 ounces per ton. It is not roasted or subjected to any further treatment.

ACCIDENTAL FORMATIONS IN THE FURNACE.—Among these iron sows are the most important, and have frequently been the source of much trouble, sometimes necessitating, as before mentioned, the blowing-out of a furnace in order to effect their removal. Besides ordinary hearth obstructions, different shaft accretions are found in varying quantity, which it is unnecessary here to discuss further, save to quote an instance, mentioned by Mr. Guyard, of a small, round furnace entirely lined from the water-jackets to within 6 inches of the feed-hole with one of these accretions a foot in thickness.

FLUE- AND CHAMBER-DUST.—Leadville being situated at an elevation of 10,000 feet above the sea, the volume of air blown into a furnace with a given blast-pressure is far greater than with the same pressure at sea-level; consequently the draught of the furnace is correspondingly increased, and the quantity of dust and fumes escaping by the stack is very large. This would seem to necessitate the employment of a very perfect system of condensing flues and chambers. In point of fact, however, as has been seen, these arrangements are, with one or two exceptions, very poor; consequently a large proportion of the dust and fumes is lost in the air. Their composition is extremely complicated, and is characterized by the presence, in considerable quantities, of chlorides, bromides, iodides, and phosphates. They carry from 25 to 60 per cent. of lead, the latter figure applying to the fumes condensed in the Bartlett filter before described, and from 30 to 40 ounces of silver to the ton, although the Bartlett filter fumes held but 4.3 ounces. The composition of the latter is otherwise remarkable in that they contain over 11 per cent. of phosphate of lead, 9 per cent. of chloro-bromo-iodide of lead, and 18 per cent. of sulphide of lead, and from the further fact, according to Mr. Guyard, that iron, zinc, and manganese exist in them entirely in the state of sulphides. It must be borne in mind, however, that these fumes were condensed at a distance of 200 feet from the furnace. Mr. Guyard has calculated the weight of calcined dust collected from one furnace of 30 to 40 tons capacity during twenty-four hours at 1,400 pounds, and estimates that, where the filter is not employed, the loss of lead equals half a ton and of silver 4½ ounces per day per furnace. On this assumption more lead is lost in the air than is collected in the dust-chambers. As already shown, the chamber- and flue-dust is mixed with lime and thrown over the ore-beds to be re-smelted. In one case, however, a furnace was specially constructed for the purpose of roasting the flue-dust, though with what object in view it is impossible to say, unless on the erroneous supposition that much arsenic is present. In point of fact, arsenic is found in it in only small quantities, and this roasting deprives the dust of the carbon which would otherwise suffice for the reduction of all the lead contained in it, besides occasioning the loss of some silver. In another smelter the flue-dust is prepared for re-smelting by melting down in a reverberatory furnace, at first with, and now without, the addition of slag. It is then run out, and after cooling it is broken up and mixed with the charges.

COST OF LABOR AND MATERIAL.

Below are given a few data relative to the prices paid for fluxes, fuel, and the average wages of employés during the census year at Leadville, which serve to give a fair idea of the economic conditions of smelting at that time:

Dolomite, per ton	$3 00 to $4 00
Hematite, per ton	8 00 to 11 50
Charcoal, per bushel	10 to 18
Coke, per ton	25 00 to 60 00
Pine wood, per cord of 2,000 to 3,000 pounds	4 50 to 5 00
Foremen, per shift of eight to twelve hours	3 00 to 6 00
Head smelters, per shift of eight to twelve hours	3 00 to 4 25
Slag wheelers, per shift of eight to twelve hours	2 50 to 4 00
Feeders, per shift of eight to twelve hours	3 00 to 4 00
Helpers, per shift of twelve hours	2 50 to 3 00
Day laborers, per shift of ten to twelve hours	2 50
Engineers, per shift of eight to twelve hours	3 50
Fuelmen, per shift of eight to twelve hours	3 00

CONCLUSION.—In conclusion, it may be said that lead smelting, as carried on in this region, while not entirely beyond criticism, has been brought to a relatively high degree of perfection, and is extremely creditable to American metallurgists. One of the most useful practical lessons that has been taught by the comparative success of the various smelting works is that this has been proportional to the more thorough training in scientific metallurgy of its managers, the completeness and accuracy with which they have ganged the operations of their furnaces by chemical tests, and the intelligence with which the results of these tests have been applied to the practical conduct of their business.

Could this lesson overcome the idea so common among us that the adaptability and "cuteness" of the American, which is in so many points acknowledged to be superior to that of other races, enable him to master the science of smelting as readily as he does any branch of trade, it might prevent an increase of the already very considerable number of abandoned smelters which dot our western hills and valleys, and save a portion of the capital which is annually wasted through gross ignorance in the various operations connected with mining.

CHAPTER VII.—PRODUCTION OF THE PRECIOUS METALS.

METHOD FOLLOWED IN COMPILATION.

Three principal methods have been adopted by statisticians in studying the bullion production of the United States.

The first and most obvious plan has been to use as a basis the receipts of domestic bullion reported by the several mints and United States assay offices, ascertaining the probable total product by adding to the figures thus obtained the amount shipped abroad, as shown by the custom-house returns, and the probable amount consumed in the arts. The objections to this method are: The amount coined within a certain period does not necessarily correspond to the production for that period. In the same way the proportion of the domestic product exported may be largely affected by the stock of precious metals on hand at any given time. Both of these variations depend primarily upon fluctuations in the bullion market and international balance of trade. An average of a ong series of years would give tolerably accurate results; but for any stated period the figures of coinage, export, and consumption in the arts are apt to be deceptive.

Assuming the source of the bullion deposited at the mints to be correctly stated, there are still serious and unavoidable defects in the custom-house statistics, notwithstanding the care taken to secure accuracy. No account is taken of bullion transported overland into Canada, nor are the export figures for doré bullion, base bullion, ores, and matte shipped abroad always to be depended upon. This difficulty is particularly manifested in the last three instances. The regulations prescribed by the custom-house authorities are not followed by penalties sufficient to insure accurate invoicing of the values thus exported. It is well known that during the period of intense speculation in gold a very large proportion of both receipts and exports, even of gold coin, was entirely hidden from official scrutiny, with a still greater margin in the bullion movement, and although the inducements to a concealment of the actual movement do not now exist in the same force it is still doubtful whether the official figures are entirely reliable. A less important source of error is the undisputed fact that not infrequently bullion of domestic production, after having been shipped abroad, is, from changes in the silver-bullion market or from the necessities of coinage, reimported into the United States.

It will thus be seen that the best results which can be hoped for from the most careful application of the "consumption and export" method are close approximations extending over considerable periods, but not the exact product for any given year. The system also fails to segregate the yield according to the productive source; and while the geographical distribution by state and territorial lines may be shown, it is hardly possible to carry the analysis further and ascertain in this way the yield of single districts or even counties.

The director of the mint has examined the bullion product of the country critically from the "consumption and export" point of view, employing as a supplementary means of information the details obtainable by correspondence and circulars scattered through the mining districts. The substantial accuracy of the estimates thus reached has been fully borne out by the results of the present investigation.

The second, or "transportation" method, consists in estimating the product from the statistics of the express companies, freight lines, and banks which have the handling of the product from its original sources. This plan would give more satisfactory results if, in the first place, all the bullion, ores, etc., were transported from the producing points through these different channels alone, and if, in the second place, none of the product were reshipped from point to point and thus twice recorded. As a matter of fact, there is a considerable portion of the gold yield sent through the mails as registered matter, and a large proportion passes from the productive source into the market through private channels. Both of these means of conveyance are affected by proximity to main lines of communication, or, on the other hand, by the absence of express or railroad facilities; and in neither can the exact effect of these circumstances be very definitely counted upon. In the Pacific states and territories the great bulk of the mine output is handled by Wells, Fargo & Co.'s express, and upon the detailed returns of the many offices of this company Mr. J. J. Valentine, general superintendent, has been enabled to furnish very valuable estimates of the bullion production, covering a long series of years. The business connections of this express company in portions of the country not covered by their agencies have rendered it possible for Mr. Valentine to frame approximate estimates of the product of the mining territory outside of that from which Wells, Fargo & Co. are the principal transporters of bullion. But the impossibility of assigning to other channels the due proportion of the outflow through them; the fact that no record is made of the value of the gold bullion and dust sent through the mails; that no reliable allowance can be made for the undervaluation of gold dust and unassayed bullion by consignors, amounting in many cases to from five to ten per cent.; that there is no satisfactory means of checking the reshipments which are twice or more times recorded, combine to create a large margin which can hardly be

definitely accounted for in making the total estimates. Notwithstanding these palpable but unavoidable defects in the system, much credit is due Mr. Valentine for the painstaking care with which he has prepared his annual estimates.

The third system is one which, were it practicable to pursue it into complete details, would lead to results more satisfactory than could be obtained in any other way. This may be termed the direct method. It would consist, if properly carried out, in obtaining from each bullion producer a statement of the quota contributed. The aggregate of the details thus reached would represent the actual total product of the country, and would moreover segregate it according to districts. In the census work conducted by the United States geological survey the plan indicated has been followed to as minute detail as it was possible to extend it with the means at command. No attempt had ever been previously made which aimed at securing individual returns throughout the whole United States with the same degree of thoroughness, though the successful adoption of the direct method by Mr. A. Del Mar, in his investigation of the silver product of Nevada in 1876, showed the advantages of the plan. But even with all the care and time expended by the experts engaged in collecting these statistics it was found to be impracticable to do more than obtain returns from the larger producers. In some instances well-based and careful estimates were submitted by the experts, covering aggregates of a large number of small mines for whole districts. In other cases, and more especially in portions of the country where placer-mining on a small scale furnished a large proportion of the yield, reliance had to be placed on extraneous data.

The chief obstacles encountered in the collection of bullion statistics directly from the producers were—

First. The wide extent of the field to be covered and the vast number of mines to be reported upon. Even were the mines located in easily accessible places, the wide range of territory over which they are scattered would render the labor of personally visiting each productive district a tedious matter. But when it is considered that they are for the most part to be found in rugged mountainous tracts, often at high altitudes, and, when destitute of railroad communication, to be reached only by stage or on horseback, some idea may be gathered of the amount of work involved.

Second. The fact that a considerable yield is derived from small mines, the product from each of which, however insignificant in itself, goes to form part of an important aggregate, and should not be neglected.

Third. The reluctance of some mine owners and superintendents to give a full account of their operations, notwithstanding the strictly confidential manner in which these individual statements have been treated. On explanation of the purposes for which the statistics were collected such objections were in most cases overruled, however, and invariably great courtesy was personally manifested.

Fourth. The fact that in a large majority of cases no systematic accounts are kept by mine owners, who were often unable to state from memory the precise output of their properties for a period which had elapsed some time before the inquiry was made.

Fifth. Many mines having changed hands during the census year, it was frequently impossible to obtain from the present holders a statement of the operations conducted prior to the change in ownership, or to communicate with the former owners if they had removed.

Sixth. When, in the case of mines worked during only a portion of the census year, or during a season limited by the weather, water supply, or other causes, operations had been suspended at the time the district was visited by the examining expert, it was often impracticable to communicate with the only persons able to supply information.

Seventh. The variation in the fiscal year of the incorporated companies makes it a matter of much difficulty to reduce the returns to a different period from that for which the books are kept.

With means still less adequate than were lately at command the census authorities in 1870 found it impossible to trace the bullion product of the country at that time. The best results reached by the deputy marshals in certain instances hardly amounted to a moiety of the actual product, as known through other sources of information. In the case of the census of 1880, even with greatly increased facilities, there were many gaps in the testimony which had to be filled out by estimates derived from other data than those collected directly by the experts. Where such estimates have been applied in the tabulation, they have been indicated by an asterisk (*). In all cases a careful scrutiny has been exercised in the selection and comparison of material. It is believed, in view of the more extended and fuller details accessible, as compared with previous researches of the same nature, that the results reached in this compilation are as close an approximation to absolute accuracy as it is possible to attain without a far greater expenditure of money and time than the subject demands.

In compiling the material at hand the following system was adopted: The returns given in the individual mine schedules were first abstracted and grouped into aggregates for districts. Information as to the operations of the different establishments being in many cases confidential, publication of the results begins with the district exhibits. These, again, are condensed into tables for counties, and finally into abstracts for whole states and territories. Where a marked discrepancy existed between the schedule returns and other reliable data the necessary additions were entered and the fact that they were estimates indicated. It is hardly necessary to remark that the schedules would show deficiencies rather than an excess as compared with correlative data. At the same time the schedules of reduction works were examined, and furnished a valuable check upon the figures derived from the mine reports. In some instances the yield was quoted in ounces of fine metal, as is customary in localities where the ore is reduced by

smelting; in others, in ounces of crude bullion, as in the case of placer gold; in still others, in dollars calculated from the assay value of the bullion; and more rarely in dollars representing the net proceeds after deducting the discount upon silver and other charges. In order to present the whole in harmonious shape, it became necessary to reduce these various denominations to a uniform standard. That adopted is the ounce of fine metal and its assay value in United States money. The terms are interchangeable, and appear side by side in the tables of production. As a preliminary step a series of conversion tables was prepared.

CLASSIFICATION OF MINES.

Mines of the precious metals are grouped under two comprehensive heads: deep mines and placer mines. The former are workings in primary deposits, in which the ore usually, though not invariably, occurs in a vein, and while the earlier operations in mines of this class may begin at or near the outcrop of the vein the tendency is always downward. The leading varieties of deep mines are:

1. Mines of free gold, or gold alloyed with a small proportion of silver.
2. Mines of silver ores, containing only traces of gold.
3. Mines yielding doré bullion from milling ores, containing both gold and silver in appreciable quantities.
4. Mines yielding base bullion from smelting ores in which the precious metals are associated with larger quantities of lead, copper, etc.

All of these divisions shade imperceptibly into each other.

Placer or gravel mines are workings in secondary or fragmentary gold deposits, including gravels and sands, and are either surface or shallow workings, as compared with those of vein mines, though in somes localities gravel beds of several hundred feet in depth occur. The leading types are:

1. Hydraulic mines.
2. Dry washings.
3. Booming and shovel-sluicing.
4. River mines.
5. Pocket mines (not to be confounded with primary pockets or concentrations in deep mines).
6. Drift mines.
7. Branch mines.
8. Black sand littoral deposits.

In the tables of production the classification under these two main heads is observed.

CLASSIFICATION OF REDUCTION WORKS.

In some of the following tables a distinction is made between the production as shown by the different reduction works, which, like the mines, are divided into two principal classes. These are, first, amalgamating mills, including:

1. Gold quartz mills.
2. Mills in which silver ore is treated in the raw state.
3. Mills in which roasting is practiced before amalgamation.
4. Concentration works.
5. Chlorination and leaching establishments.
6. Arrastras.

The second class includes the several varieties of smelting works in which the production of base bullion, matte, or speiss is a preliminary step toward the final extraction of the precious metals.

Placer mines, with the exception of pocket mines and branch mines, require no reducing process, and in the two exceptions named the mill process is not always a necessary concomitant, in the former, in fact, but rarely. Various systems of reduction by chlorination and amalgamation have also been applied to black-sand deposits and refractory conglomerates containing placer gold, but not to an extent affecting the general principle of classification here maintained.

[NOTE.—In each of the tables of production and throughout this discussion the following explanations apply:

The short ton of 2,000 pounds is invariably used.

The ore tonnage is stated in gross tons; the assay values are of net tons, without allowance for moisture.

Mint values are assumed in all cases. The weight of bullion is given in troy ounces of fine metal. The gold ounce is taken at $20.671834, and the silver ounce at $1.2929. A statement of the estimated market value of the silver is elsewhere appended.

No account is taken of the value of the silver alloyed with placer gold in the primary production tables, as, with very few exceptions, no allowance is made for it in selling. This is treated of separately, and the proper addition made in the final summary.

The bullion yield is given according to the district in which the ore producing it was raised, without regard to the locality where the ore was reduced. This method of stating the product apportions it with reference to the original source so far as it is practicable to trace it. Were the yield to be credited to the reduction works, Omaha, Chicago, Saint Louis, Newark, New York, and other points remote from the mines, would appear as large producing centers.

Individual estimated amounts are designated by an asterisk (*), and where such estimates form a considerable proportion of the totals, the fact is similarly indicated.]

For a condensed summary of the total product the reader is referred to Tables CXXIII, CXXIV, and CXXIX, and the accompanying text pages, 358, 359, and 361, respectively.

STATISTICS OF THE PACIFIC DIVISION.

CALIFORNIA.

In production of gold California still holds the first place. Previous to the discovery of the Bodie district the placer mines furnished more than two-thirds of the total gold output of the state, but the large yield of that district, amounting to over two and three-quarter millions in gold during the year, in addition to the considerable silver product, has placed the deep mines about on a par with the placers in point of productiveness. The amount of silver contributed by California is relatively small, and comes mainly from two adjoining counties, Inyo and Mono.

There is a larger number of actively working mines in California than in any other state or territory, as, owing to the settled condition, transportation facilities, and comparative cheapness of labor and supplies, it is possible to mine deposits of lower grade than could be made profitable in localities having less advantages of position. The result is that there are, besides a few large incorporated companies, a great many mining properties worked on the small scale, but still profitably, by individual owners. The collection of accurate statistics regarding these smaller claims is a very tedious and also somewhat uncertain matter. Schedule returns were received from 128 deep mines, 147 placer mines, 57 amalgamating mills, concentration and leaching works, 9 arrastras, and 4 smelting works in this state. These include most of the more important establishments, and are supplemented by general reports, covering in some cases whole districts. But with all the care taken by the census experts to cover thoroughly the ground the subject was by no means exhausted, and in several cases in the accompanying tabulations resort has been had to information from outside sources.

California furnishes 71.47 per cent. of the total placer product of the United States and 40.09 per cent. of the total gold product of the deep mines, or 51.38 per cent. of the total gold product of the country (from all sources). The yield in silver, however, is only 2.80 per cent. of the total, California standing sixth in rank as a producer of the latter metal. In proportion to its area, again, California leads in production of gold, with an average of $108 30 per square mile; is sixth in its silver yield of $7 27 per square mile; and third as to its output of both metals, $115 57 per square mile. As the population of the state has largely increased, while the mine production has remained nearly at a standstill for some years, the showing in relation to population is less favorable, the yield of gold being only $19 83, silver $1 33, and that of both the precious metals only $21 16 per capita, placing California fifth as to gold, and eighth as to silver and the total, in the rank of the states. The prosperity of the state is not, however, dependent upon its mines in the same degree as formerly, agriculture and manufacturing having outstripped the earlier industry.

TABLE CXXI.—CALIFORNIA—PRODUCTION OF DEEP

	County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dollars.	Dolls.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	AMADOR.													
1	Amador City (a)	38,112	18 67	.....	18 67	34,422.7	711,580	.....	.....	711,580	38,112	15 45	.....	15 45
2	Drytown	104	105 55	.....	105 55	531.0	10,977	.....	.....	10,977	104	95 00	.....	95 00
3	Jackson	26,620	8 16	.....	8 16	10,504.8	217,153	.....	.....	217,153	26,620	8 16	.....	8 16
4	Pine Grove	500	*35 00	.....	*35 00	*846.5	*17,499	.....	.....	*17,499	18	31 50	.....	31 50
5	Pioneer	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	Plymouth	40,369	14 64	.....	14 64	28,589.6	590,999	.....	.....	590,999	40,369	11 81	.....	11 81
7	Sutter Creek	6,636	10 55	.....	10 55	3,388.5	70,047	.....	.....	70,047	6,636	9 06	.....	9 06
8	Volcano	2,277	25 13	.....	25 13	2,773.3	57,329	.....	.....	57,329	2,277	20 14	.....	20 14
	Total	114,618	14 62	.....	14 62	81,056.4	1,675,584	.....	.....	1,675,584	108,136	12 49	.....	12 49
	CALAVERAS.													
1	Angel's Camp	1,900	14 58	.....	14 58	1,340.0	27,700	.....	.....	27,700	1,900	11 32	.....	11 32
2	Carson Hill	3	*6,783 00	.....	*6,783 00	*997.5	*20,620	.....	.....	*20,620	3	6,627 00	.....	6,627 00
3	Independence	2,600	60 65	.....	60 65	7,628.1	157,687	.....	.....	157,687	2,600	48 52	.....	48 52
4	Mesquite	125	121 00	.....	121 00	731.7	15,125	.....	.....	15,125	.....	.....	.....	.....
5	Mokelumne Hill (b)	38,000	6 23	.....	6 23	11,464.8	236,999	.....	.....	236,999	36,000	5 00	.....	5 00
6	Washington	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	42,628	10 74	.....	10 74	22,162.1	458,131	.....	.....	458,131	40,503	8 58	.....	8 58
	EL DORADO.													
1	Kelsey	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	Mud Spring or Springfield	3,620	25 89	.....	25 89	4,533.4	93,714	.....	.....	93,714	3,620	20 61	.....	20 61
3	Placerville	900	27 72	.....	27 72	1,298.9	26,850	.....	.....	26,850	900	24 75	.....	24 75
	Total	4,520	26 76	.....	26 76	5,832.3	120,564	.....	.....	120,564	4,520	21 21	.....	21 21
	FRESNO.													
1	Potter Ridge (c)	578	150 00	13 00	163 00	4,194.1	86,700	5,812	7,514	94,214	578	120 00	10 40	130 40
	Total	578	150 00	13 00	163 00	4,194.1	86,700	5,812	7,514	94,214	578	120 00	10 40	130 40
	INYO.													
1	Alabama	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	Beverage	354	*65 00	.....	65 00	1,113.1	23,010	.....	.....	23,010	354	50 00	.....	50 00
3	Cerro Gordo	4,223	94	83 86	84 80	191.2	3,952	273,962	354,206	358,158	4,223	79	33 27	34 06
4	Coso (d)	350	2 98	*55 94	58 92	50.5	1,044	15,144	19,580	20,624	350	2 68	50 35	53 03
5	Deep Spring Valley	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	Fish Springs	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7	Kearsarge	200	.....	*55 00	*55 00	.....	.....	8,508	*11,000	*11,000	200	.....	47 00	47 00
8	Lee	100	.....	*75 00	*75 00	.....	.....	5,806	*7,506	*7,506	*100	.....	65 00	65 00
9	Lookout (e)	260	2 80	80 00	82 80	35.2	728	16,088	20,800	21,528	260	2 43	71 15	73 58
10	Pajaro	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
11	Panamint	600	.....	*70 00	*70 00	.....	.....	32,480	41,904	41,904	600	.....	61 90	61 90
12	Russ	500	*9 00	*8 00	*17 00	217.7	4,500	3,094	4,000	8,500	500	5 85	5 20	11 05
13	Snow's Cañon	100	4 00	17 00	21 00	19.3	399	1,315	1,700	2,099	100	2 00	13 00	15 00
14	Swansea	27	.....	257 72	257 72	.....	.....	5,382	6,958	6,958	27	.....	206 18	206 18
15	Tarrytown	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	Ubehebe (f)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	Union	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	Wauconda (f)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
19	Wild Rose	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	6,714	5 01	69 66	74 67	1,627.0	33,633	361,779	467,744	501,377	6,714	3 83	35 62	39 45
	LASSEN.													
1	Hayden Hill	2,079	21 08	63	21 71	*2,120.2	*43,828	*1,009	*1,305	*45,133	2,079	16 71	50	17 21
	Total	2,079	21 08	63	21 71	*2,120.2	*43,828	*1,009	*1,305	*45,133	2,079	16 71	50	17 21
	LOS ANGELES.													
1	Silverado	200	.....	160 00	160 00	.....	.....	24,750	32,000	32,000	200	.....	147 00	147 00
	Total	200	.....	160 00	160 00	.....	.....	24,750	32,000	32,000	200	.....	147 00	147 00

*Estimated.

MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.					
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.	
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ozs.	Dolls.	Dolls.	Ounces.	Dollars.	Ozs.	Dolls.	Dollars.	
28,488.0	588,899	.....	.....	588,899	.....	.....	.....	.....	.....	.....	2,733.2	56,500	.....	.....	56,500	1
477.9	9,879	.....	.....	9,879	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
8,146.4	168,401	.....	.....	168,401	6,000	435.4	9,001	.....	.....	9,001	.....	.....	.....	.....	.....	3
27.4	567	.....	.....	567	482	816.1	16,870	.....	.....	16,870	.....	.....	.....	.....	.....	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
23,070.1	476,901	.....	.....	476,901	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
2,904.4	60,040	.....	.....	60,040	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
2,218.5	45,860	.....	.....	45,860	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
65,332.7	1,350,547	.....	.....	1,350,547	6,482	1,251.5	25,871	.....	.....	25,871	2,733.2	56,500	.....	.....	56,500	
1,040.0	21,499	.....	.....	21,499	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
967.5	20,000	.....	.....	20,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
6,102.5	126,150	.....	.....	126,150	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
.....	.....	.....	.....	.....	125	731.6	15,124	.....	.....	15,124	.....	.....	.....	.....	.....	4
8,707.5	180,000	.....	.....	180,000	2,000	580.5	12,000	.....	.....	12,000	48.4	1,000	.....	.....	1,000	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
16,817.5	347,649	.....	.....	347,649	2,125	1,312.1	27,124	.....	.....	27,124	48.4	1,000	.....	.....	1,000	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
3,608.8	74,601	.....	.....	74,601	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
1,077.8	22,280	.....	.....	22,280	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
4,686.6	96,881	.....	.....	96,881	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
3,355.3	69,360	4,649	6,011	75,371	.....	.....	.....	.....	.....	.....	156.7	3,239	217	281	3,520	1
3,355.3	69,360	4,649	6,011	75,371	.....	.....	.....	.....	.....	.....	156.7	3,239	217	281	3,520	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
856.2	17,699	.....	.....	17,699	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
160.0	3,307	168,684	140,517	143,824	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
45.4	939	13,630	17,622	18,561	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	7,270	9,400	9,400	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	5,027	6,500	6,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
30.6	633	14,308	18,499	19,132	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
.....	.....	28,726	37,140	37,140	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
141.5	2,925	2,011	2,600	5,525	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
9.7	200	1,006	1,300	1,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	4,306	5,567	5,567	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
1,343.4	25,703	184,968	239,145	264,848	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
1,680.5	34,739	802	1,037	35,776	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1,680.5	34,739	802	1,037	35,776	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
.....	.....	22,740	29,400	29,400	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	22,740	29,400	29,400	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	

TABLE CXXI.—CALIFORNIA—PRODUCTION OF DEEP MINES

	County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dollars.	Dolls.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	MARIPOSA.													
1	Coulterville	300	50 00	.....	50 00	723.6	15,000	.....	.....	15,000	300	37 50	.....	37 50
2	Hornitos (g)	12,000	15 00	.....	15 00	8,707.5	180,000	.....	.....	180,000	12,000	9 00	.....	9 00
3	Mariposa Estate (h)	4,360	20 62	.....	20 62	4,349.9	89,920	.....	.....	89,920	4,360	15 78	.....	15 78
	Total	16,660	17 10	.....	17 10	13,783.0	284,920	.....	.....	284,920	16,660	10 69	.....	10 69
	MONO.													
1	Bishop Creek	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	Blind Spring (i)	174	1 95	249 17	251 12	16.4	339	83,533	43,255	43,594	174	1 78	243 39	245 97
3	Bodie	56,072	53 00	3 17	61 17	143,756.5	2,971,711	354,235	457,990	3,429,701	55,969	49 42	6 10	55 52
4	Clover Patch	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5	Homer	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	Indian	640	.....	142 66	142 66	.....	.....	70,616	91,300	91,300	640	.....	125 50	125 50
7	Montgomery, or White Peak	300	.....	20 00	20 00	.....	.....	4,641	6,000	6,000	300	.....	16 67	16 67
8	Pinte	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9	Scattered	25	.....	*300 00	*300 00	.....	.....	*5,801	*7,500	*7,500	25	.....	264 04	264 04
	Total	57,211	51 95	10 59	62 54	143,772.9	2,972,050	468,826	606,145	3,578,195	57,108	48 44	8 33	56 77
	NAPA.													
1	Calistoga	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	NEVADA.													
1	Grass Valley	28,989	20 26	.....	20 26	28,408.7	587,260	.....	.....	587,260	28,989	15 19	.....	15 19
2	Nevada City	27,814	22 57	1 05	23 62	30,374.9	627,905	22,328	28,868	656,773	27,814	14 25	68	14 93
3	Willow Valley	1,630	40 00	.....	40 00	3,154.0	65,199	.....	.....	65,199	1,630	32 00	.....	32 00
	Total	58,433	21 91	40	22 40	61,937.6	1,280,364	22,328	28,868	1,309,232	58,433	15 21	33	15 54
	PLACER.													
1	Colfax (j)	3,000	25 00	.....	25 00	3,628.1	75,000	.....	.....	75,000	3,000	20 00	.....	20 00
	Total	3,000	25 00	.....	25 00	3,628.1	75,000	.....	.....	75,000	3,000	20 00	.....	20 00
	PLUMAS.													
1	Genesee Valley	400	*9 75	*25	*10 00	188.6	3,899	77	100	3,999	400	7 00	05	7 05
2	Indian Valley (k)	37,960	8 72	12	8 84	16,016.4	331,088	3,254	4,207	335,295	37,960	6 11	08	6 19
3	Quartz Township (l)	74,919	*9 21	*08	*9 29	33,386.1	*690,152	4,486	*5,800	*695,952	74,919	6 91	06	6 97
4	Seneca	600	6 29	06	6 35	182.5	3,773	31	40	3,813	600	4 72	05	4 77
	Total	113,879	9 03	09	9 12	49,773.6	1,028,912	7,848	10,147	1,039,059	113,879	6 63	06	6 69
	SAN BERNARDINO.													
1	Clark (m)	389	.....	193 76	193 76	.....	.....	58,297	75,372	75,372	389	.....	164 55	164 55
2	Dry Lake	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	Silver Mountain	*100	*100 00	*82 00	*182 00	483.7	9,999	6,343	8,201	18,200	.....	.....	.....	.....
	Total	489	20 45	170 90	191 35	483.7	9,999	64,640	83,573	93,572	389	.....	164 55	164 55
	SAN DIEGO.													
1	Banner	300	40 00	.....	40 00	580.5	12,000	.....	.....	12,000	300	30 00	.....	30 00
2	Cargo Muchacho	10,000	22 00	.....	22 00	10,642.5	220,000	.....	.....	220,000	10,000	15 40	.....	15 40
3	Julian	213	*52 81	.....	*52 81	544.2	*11,250	.....	.....	*11,250	213	41 55	.....	41 55
4	Picacho	6,000	21 00	.....	21 00	6,095.2	125,999	.....	.....	125,999	6,000	11 00	.....	11 00
5	Pinecate	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	16,513	22 36	.....	22 36	17,862.4	369,249	.....	.....	369,249	16,513	14 40	.....	14 40
	SHASTA.													
1	French Gulch	500	*85 00	.....	*85 00	*2,055.9	*42,499	.....	.....	*42,499	*500	*77 00	.....	*77 00
2	Iron Mountain	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	Pittsburgh	6,000	*2 50	*13 00	*20 50	*725.6	*14,999	*83,533	*108,000	*122,999	6,000	*2 00	*14 90	*16 90
4	Whiskey Creek	1,180	*44 32	.....	*44 32	*2,530.0	*52,300	.....	.....	*52,300	1,180	34 49	.....	34 49
5	Scattered	330	54 54	.....	54 54	870.8	18,001	.....	.....	18,001	*200	*20 00	.....	*20 00
	Total	8,010	*15 96	*13 48	*29 44	*6,182.3	*127,799	*83,533	*108,000	*235,799	7,880	12 06	*11 34	23 42

*Estimated.

FOR THE YEAR ENDING MAY 31, 1880—Continued.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.					
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.	
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ozs.	Dolls.	Dolls.	Ounces.	Dollars.	Ozs.	Dolls.	Dollars.	
544.2	11,250	.....	.....	11,250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
5,224.5	108,000	.....	.....	108,000	.....	.....	.....	.....	.....	.....	25.4	525	.....	.....	525	2
3,328.2	68,800	.....	.....	68,800	.....	.....	.....	.....	.....	.....	6,467.7	133,699	.....	.....	133,699	3
9,096.9	188,050	.....	.....	188,050	.....	.....	.....	.....	.....	.....	6,493.1	134,224	.....	.....	134,224	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
14.9	308	32,743	42,333	42,641	.....	.....	.....	.....	.....	.....	.....	.....	696	900	900	2
123,801.7	2,765,927	264,038	341,375	3,107,302	103	138.1	2,855	939	1,214	4,069	.....	.....	.....	.....	.....	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
.....	.....	62,122	80,317	80,317	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	3,867	5,000	5,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
.....	.....	5,105	6,601	6,601	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
123,816.6	2,766,235	367,875	475,626	3,241,861	103	138.1	2,855	939	1,214	4,069	.....	.....	696	900	900	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
21,306.5	440,445	.....	.....	440,445	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
19,171.2	396,303	14,737	19,053	415,356	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
2,523.2	52,159	.....	.....	52,159	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
43,000.9	888,907	14,737	19,053	907,960	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
2,902.5	60,000	.....	.....	60,000	.....	.....	.....	.....	.....	.....	387	8,000	.....	.....	8,000	1
2,902.5	60,000	.....	.....	60,000	.....	.....	.....	.....	.....	.....	387	8,000	.....	.....	8,000	
135.4	2,799	15	20	2,819	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
11,224.6	232,033	2,206	2,852	234,885	.....	.....	.....	.....	.....	.....	28.1	581	5	7	588	2
25,039.6	517,614	3,364	4,349	521,963	.....	.....	.....	.....	.....	.....	47.1	974	8	10	984	3
136.9	2,830	23	30	2,860	.....	.....	.....	.....	.....	.....	2,077.4	42,943	8	10	42,953	4
36,536.5	755,276	5,608	7,251	762,527	.....	.....	.....	.....	.....	.....	2,152.6	44,498	21	27	44,525	
.....	.....	49,540	64,050	64,050	.....	.....	.....	.....	.....	.....	.....	.....	824	1,065	1,065	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
.....	.....	.....	.....	.....	100	483.7	9,999	6,342	8,200	18,199	.....	.....	.....	.....	.....	3
.....	.....	49,540	64,050	64,050	100	483.7	9,999	6,342	8,200	18,199	.....	.....	824	1,065	1,065	
435.4	9,000	.....	.....	9,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
7,449.7	154,000	.....	.....	154,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
428.1	8,850	.....	.....	8,850	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
3,192.8	66,000	.....	.....	66,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
11,506.0	237,850	.....	.....	237,850	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
*1,862.4	*38,500	.....	.....	*38,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
*580.5	*12,000	*69,145	*89,398	*101,398	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
1,968.9	40,700	.....	.....	40,700	.....	.....	.....	.....	.....	.....	53.1	1,201	6,914	8,939	10,140	3
193.5	4,000	.....	.....	4,000	130	628.9	13,001	.....	.....	13,001	.....	.....	.....	.....	.....	4
4,605.8	95,200	*69,145	*89,398	184,598	130	628.9	13,001	.....	.....	13,001	53.1	1,201	6,914	8,939	10,140	5

*Estimated.

TABLE CXXI.—CALIFORNIA—PRODUCTION OF DEEP MINES

	County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dollars.	Dolls.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	SISKIYOU.													
1	Quartz Valley	500	26 13	11 72	37 85	632.0	13,064	4,533	5,861	18,925	500	19 59	8 79	28 38
2	Sawyer's Bar	2,500	17 75	25	18 00	2,146.7	44,376	483	625	45,001	2,500	13 02	12	13 14
3	South Fork Salmon	19,290	*11 12	*15	*11 27	*10,375.2	*214,475	2,201	*2,845	*217,320	19,290	8 34	11	8 45
	Total	22,290	12 20	44	12 64	13,153.9	271,915	7,217	9,331	281,246	22,290	9 11	31	9 42
	TRINITY.													
1	Ballychoop	*400	*30 00	.....	*30 00	*580.5	*12,000	.....	.....	*12,000	*400	*25 00	.....	*25 00
2	Deadwood	400	*40 00	.....	*40 00	*774.0	*16,000	.....	.....	*16,000	400	30 00	.....	30 00
	Total	800	*35 00	.....	*35 00	*1,354.5	*28,000	.....	.....	*28,000	800	27.50	.....	27 50
	TUOLUMNE.													
1	Confidence	*3,006	*12 44	.....	*12 44	*1,808.3	*37,380	.....	.....	*37,380	*3,006	*10 40	.....	*10 40
2	Jamestown	2,200	*25 00	.....	*25 00	2,660.6	55,000	.....	.....	55,000	2,200	*20 00	.....	*20 00
3	Riverside	200	15 00	.....	15 00	145.1	3,000	.....	.....	3,000	200	10 00	.....	10 00
4	Sonora	3,000	8 60	.....	8 60	1,248.4	25,806	.....	.....	25,806	3,000	8 00	.....	8 00
5	Soulsbyville (a)	2,000	*18 00	*2 00	*20 00	*1,741.5	*36,000	*3,094	*4,000	*40,000	2,000	13 50	1 50	15 00
	Total	10,406	15 11	38	15 49	7,608.9	157,186	*3,094	*4,000	161,186	10,406	12 32	29	12 61

* Estimated.
a From tailings.
b From 500 tons tailings.
c From 27 tons ore prior to census year.
d Lead 30 per cent.
e Lead 30 per cent.=62 tons.
f Abandoned.
g From 175 tons tailings.

TABLE CXXII.—CALIFORNIA—RECAPITULATION BY COUNTIES OF

	County.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
1	Amador	114,618	14 62	.....	14 62	81,056.4	1,675,584	.....	.....	1,675,584	108,136	12 49	.....	12 49
2	Calaveras	42,628	10 74	.....	10 74	22,163.1	458,131	.....	.....	458,131	40,503	8 58	.....	8 58
3	El Dorado	4,520	26 76	.....	26 76	5,832.3	120,564	.....	.....	120,564	4,520	21 21	.....	21 21
4	Fresno	578	150 00	13 00	163 00	4,194.1	86,700	5,812	7,514	94,214	578	120 00	10 40	130 40
5	Inyo	6,714	5 01	69 66	74 67	1,627.0	33,633	361,779	467,744	501,377	6,714	3 83	35 62	39 45
6	Lassen	2,079	21 68	63	21 71	*2,120.2	*43,828	*1,009	*1,305	*45,133	2,079	16 71	50	17 21
7	Los Angeles	200	.....	160 00	160 00	.....	.....	24,750	32,000	32,000	200	.....	147 00	147 00
8	Mariposa	16,660	17 10	.....	17 10	13,783.0	284,920	.....	.....	284,920	16,660	10 69	.....	10 69
9	Mono	57,211	51 95	10 59	62 54	143,772.9	2,972,050	468,826	606,145	3,578,195	57,108	48 44	8 33	56 77
10	Nevada	58,433	21 91	49	22 40	61,967.6	1,280,364	22,228	28,868	1,309,232	58,433	15 21	33	15 54
11	Placer	3,000	25 00	.....	25 00	3,638.1	75,000	.....	.....	75,000	3,000	20 00	.....	20 00
12	Plumas	113,879	9 03	09	9 12	49,773.6	1,028,912	7,848	10,147	1,039,059	113,879	6 63	06	6 69
13	San Bernardino	489	20 45	170 90	191 35	483.7	9,999	64,640	83,573	93,572	389	.....	164 55	164 55
14	San Diego	16,513	22 36	.....	22 36	17,862.4	369,249	.....	.....	369,249	16,513	14 40	.....	14 40
15	Shasta	8,010	$15 96	*12 48	*28 44	*6,182.3	*127,799	*83,533	*108,000	*235,799	7,880	12 08	*11 34	23 42
16	Siskiyou	22,290	12 20	44	12 64	13,153.9	271,915	7,217	9,331	281,246	22,290	9 11	31	9 42
17	Trinity	800	*35 00	.....	*35 00	*1,354.5	*28,000	.....	.....	*28,000	800	27 50	.....	27 50
18	Tuolumne	10,406	15 11	38	15 49	7,608.9	157,186	*3,094	*4,000	161,186	10,406	12 32	29	12 61
	Total	479,028	18 84	2 84	21 68	436,528.0	9,023,834	1,050,836	1,358,627	10,382,461	470,088	16 10	2 00	18 10
	Additional production estimated from transportation statistics	*65,213	*18 84	*2 84	*21 68	59,434.1	*1,228,612	143,248	*185,205	*1,413,817	*65,213	*16 10	*2 00	*18 10
	Grand total	544,241	18 84	2 84	21 68	495,962.1	10,252,446	1,194,084	1,543,832	11,796,278	535,301	16 10	2 00	18 10

* Estimated.

FOR THE YEAR ENDING MAY 31, 1880—Continued.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ozs.	Dolls.	Dolls.	Ounces.	Dollars.	Ozs.	Dolls.	Dollars.	
474.0	9,798	3,400	4,396	14,194												
1,574.6	32,550	223	288	32,838												1
7,781.4	160,856	1,650	2,134	162,990												2
9,830.0	203,204	5,273	6,818	210,022												3
*483.7	*10,000			*10,000												
580.5	12,000			12,000												1
1,064.2	22,000			22,000												2
*1,512.2	*31,260			*31,260												
*2,128.5	*44,000			*44,000												1
96.7	2,000			2,000												2
1,161.0	24,000			24,000												3
1,306.1	27,000	2,320	3,000	30,000												4
6,204.5	128,260	2,320	3,000	131,260							73.1	1,511	146	189	1,700	5
											73.1	1,511	146	189	1,700	

* Estimated.
h From 7,640 tons raised prior to census year.
i From 48 tons tailings.
j From 1,000 tons tailings.
k From 236 tons ore prior to census year.
l From 302 tons tailings.
m From 270 tons tailings.
n From tailings sold.

PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ozs.	Dolls.	Dolls.	Ounces.	Dollars.	Ozs.	Dolls.	Dolls.	
65,332.7	1,350,547			1,350,547	6,482	1,251.5	25,871			25,871	2,733.2	56,500			56,500	1
16,817.5	347,649			347,649	2,125	1,312.1	27,124			27,124	42.4	1,000			1,000	2
4,686.6	96,881			96,881												3
3,355.3	69,360	4,649	6,011	75,371							156.7	3,239	217	281	3,520	4
1,243.4	25,703	184,968	239,145	264,848												5
1,680.5	34,739	802	1,037	35,776												6
		22,740	29,400	29,400												7
9,096.9	188,050			188,050												8
133,816.6	2,766,235	367,875	475,626	3,241,861	103	138.1	2,855	989	1,214	4,069	6,488.1	134,224			134,224	9
43,000.9	888,907	14,737	19,053	907,960									696	900	900	10
2,902.5	60,000			60,000												11
36,538.5	755,276	5,908	7,251	762,527							387.0	8,000			8,000	12
		49,540	64,050	64,050	100	483.7	9,999	6,242	8,200	18,199	2,133.6	44,496	21	27	44,535	13
11,506.0	237,850			237,850									824	1,065	1,065	14
4,605.3	95,200	*89,145	*89,298	184,506	130	628.9	13,001			13,001	58.1	1,201	6,914	8,939	10,140	15
9,830.0	203,204	5,273	6,818	210,022												16
1,064.2	22,000			22,000												17
6,204.5	128,260	2,320	3,000	131,260							73.1	1,511	146	189	1,700	18
351,679.4	7,269,861	727,657	940,789	8,210,650	8,940	3,814.3	78,850	7,231	9,414	88,264	12,102.2	250,173	8,818	11,401	261,574	
50,790.1	*1,049,925	106,879	*138,426	*1,188,351												
402,469.5	8,319,786	828,536	1,071,215	9,391,001	8,940	3,814.3	78,850	7,231	9,414	88,264	12,102.2	250,173	8,818	11,401	261,574	

TABLE CXXIII.—CALIFORNIA—PRODUCTION (GOLD) OF HYDRAULIC, PLACER, DRIFT, AND RIVER MINES FOR THE YEAR ENDING MAY 31, 1880.

County and district.	Gold.			
	Totals, by districts.		Totals, by counties.	
	Ounces.	Dollars.	Ounces.	Dollars.
BUTTE.				
Centerville and Helltown	725.6	15,000	15,730.3	325,174
Cherokee Flat	13,257.5	274,057		
Magalia or Dog Town	828.1	17,118		
Morris Ravine	435.4	9,000		
Oroville	483.7	9,999		
CALAVERAS.				
Mokelumne Hill	3,069.4	63,450	4,065.8	56,451
Robinson's Ferry	725.6	15,000		
Vallecito	870.8	18,001		
DEL NORTE.				
Scattered	6,208.0	128,331	6,208.0	128,331
EL DORADO.				
Scattered	*24,877.7	*514,268	*24,877.7	*514,268
HUMBOLDT.				
Gold Bluffs	1,306.1	27,000	3,724.9	77,001
Orleans Bar	2,418.8	50,001		
MONO.				
Bodie	1,219.0	25,199	1,219.0	25,199
NEVADA.				
Scattered	2,062.3	42,631	2,062.3	42,631
PLACER.				
Bath	3,144.4	65,000	13,906.2	289,368
Dutch Flat	2,128.5	44,000		
Gold Run	2,612.2	53,999		
Iowa Hill	774.0	16,000		
Michigan Bluffs	5,339.1	110,369		
PLUMAS.				
Claremont			7,946.0	164,259
Light's Cañon	290.2	5,999		
Moonlight Mountain	290.3	6,001		
North Fork, Feather River	4,081.7	84,376		
Seneca	340.3	7,035		
Scattered	2,943.5	60,848		
SHASTA.			21,789.7	450,432
Buckeye	696.6	14,400		
French Gulch	1,393.8	28,813		
Igo				
Northern Shasta County	5,201.3	107,520		
Sawmill Flat	182.8	3,779		
Shasta City	1,253.9	25,920		
Southern Shasta County	10,158.8	210,000		
Scattered	2,902.5	60,000		
SISKIYOU.				
Callahan's Ranch	3,984.7	82,371		
Cottonwood	580.5	12,000		

County and district.	Gold.			
	Totals, by districts.		Totals, by counties.	
	Ounces.	Dollars.	Ounces.	Dollars.
SISKIYOU—continued.				
Galena Hill	483.8	10,001	23,412.1	483,992
Greenhorn	657.9	13,600		
Humbug	1,879.4	38,851		
Indian Creek	712.4	14,726		
McAdam's Creek	2,419.5	50,015		
Oro Fino	943.5	19,503		
Rattlesnake Creek	314.4	6,500		
Sawyer's Bar	3,628.1	75,000		
Scind Valley	205.1	4,240		
Scott Valley	725.6	15,000		
South Fork, Salmon River	3,773.3	78,001		
Yreka	3,104.9	64,184		
STANISLAUS.				
La Grange	3,030.7	62,650	3,030.7	62,650
TRINITY.				
Arkansas Bar			37,635.7	777,999
Ballychoop				
Boalt's Hill				
Buckeye Mountain				
Cañon Creek				
Coffee Creek				
Cox's Bar				
Douglas City				
Hay Fork				
Indian Creek				
Junction City				
Minersville				
New River				
Oregon Gulch				
Red Hill				
South Fork				
Tayler's Flat				
Trinity Center				
Weaver Basin				
TUOLUMNE.				
Big Oak Flat			*27,081.7	*a559,828
Chinese Camp				
Groveland				
Jacksonville				
Montezuma				
Scattered				
YUBA.				
Scattered	*50,423.6	*1,042,349	*50,423.6	*1,042,349
Total	243,806.7	5,039,932	243,806.7	5,039,932
Additional production estimated from transportation statistics, not traceable by counties			*171,298.3	*3,541,050
Grand total			415,105.0	8,580,982

* Estimated.

a Including $300,000 from "pocket" mines.

DISTRIBUTION.—Tables CXXI and CXXIII are intended to show the distribution of the production as represented by the schedules, but not the actual amount of bullion produced by each county, a considerable part of the producing mines not having been reported upon by the experts. The following table presents the best estimates of the yield by counties which the schedules, combined with transportation statistics and all other sources of information at command, and a personal knowledge of many of the localities, have made practicable. It is merely an approximation to the truth, though it is believed to be sufficiently accurate for most purposes. A faultless table of production by counties could be prepared only at an expense entirely incommensurate with its usefulness:

County.	GOLD.			Silver.	Total.	County.	GOLD.			Silver.	Total.
	Deep mines.	Placer mines.	Total.				Deep mines.	Placer mines.	Total.		
Total	$8,569,950	$8,580,962	$17,150,941	$1,062,616	$18,223,557	Mono	$2,706,235	$25,100	$2,791,434	$476,526	$3,267,960
Alpine	60,000		60,000		60,000	Nevada	1,100,000	1,750,000	2,850,000	19,053	2,869,053
Amador	1,407,047	100,000	1,507,047		1,507,047	Placer	175,000	850,000	1,025,000		1,025,000
Butte		450,000	450,000		450,000	Plumas	820,255	248,584	1,068,839	7,278	1,076,117
Calaveras	435,000	145,000	580,000		580,000	Sacramento		75,000	75,000		75,000
Del Norte		128,231	128,231		128,231	San Bernardino				65,115	65,115
El Dorado	96,881	514,268	611,149		611,149	San Diego	237,850		237,850		237,850
Fresno	72,500		72,500	6,292	78,891	Shasta	96,401	450,432	546,833	98,337	645,170
Humboldt		130,000	130,000		130,000	Sierra	330,000	600,000	990,000		990,000
Inyo	25,703		25,703	220,145	264,848	Siskiyou	203,204	483,992	687,196	6,818	694,014
Kern	125,000		125,000		125,000	Stanislaus		100,000	100,000		100,000
Lassen	34,739		34,739	1,037	35,776	Trinity	22,000	777,999	799,999		799,999
Los Angeles				29,400	29,400	Tuolumne	129,771	550,828	680,599	3,189	683,788
Mariposa	322,274		322,274		322,274	Yuba		1,042,349	1,042,349		1,042,349
Modoc	10,000		10,000		10,000	Scattered	100,000	150,000	250,000	130,426	380,426

NEVADA.

The production of this state shows a considerable decline, as compared with that of the preceding six years. This is not due to any general falling off in the prosperity of the mining industry of the state, but to the decrease in the yield of the leading source, the Comstock lode. From 1871 to 1879, Nevada had outranked all the other states and territories in its output of the precious metals; but in the present census year it has fallen to the third place, having been passed by both Colorado and California. With the yield of the outside districts maintained at the existing rate of production, an important discovery of ore in the Comstock would perhaps raise Nevada again to the first rank. And even without any striking new developments, there is still a reserve of low-grade ore and tailings remaining unworked, sufficient to give a large and steady product for many years to come.

In 1876 the yield of the Comstock, according to Mr. Del Mar's careful analysis, was: gold, $18,002,906; silver, $20,570,078; total, $38,572,984. During the census year the product of the whole Comstock district, including the Virginia, Gold Hill, and Devil's Gate subdistricts, the outlying veins, such as the Occidental, etc., and the yield of tailings worked at various points throughout the entire tract known as the Washoe country, was: gold, $3,109,156; silver, $3,813,174; total, $6,922,330; showing a decline of $31,650,654, or 82.06 per cent., since 1876.

The bullion product of Nevada represents an average of $44 16 gold, $112 29 silver, and $156 45 gold and silver for each square mile of its area. In this respect Nevada is surpassed by Colorado, the figures for which are $25 98 gold, $159 24 silver, and $185 22 total. But with reference to its population, Nevada, even with the reduced output, remains the richest of the mining states and territories, as its annual product, if distributed equally per capita, would give $78 51 gold, $199 63 silver, and $278 14 total to every man, woman, and child within its borders. Notwithstanding the large proportion of adult males, it will be seen that this would be a fair income for the actual working population. The Nevada mines, however, are largely owned outside the state, and although they have not, taken as a whole, been profitable during the year, the local disbursements in wages, etc., continue steadily, so that the inhabitants have a direct interest in the prosecution of work, independent of the question of ownership.

Tables CXXIV and CXXV exhibit the yield of the state in detail.

The individual returns of several leading Comstock mines are given in Table CXXVI.

TABLE CXXIV.—NEVADA—PRODUCTION OF DEEP

	County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	ELKO.													
1	Blue Jacket	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	Columbia	2,000	1 00	65 00	66 00	96.8	2,001	100,549	130,000	132,001	2,000	83	53 34	54 16
3	Good Hope	*100	.....	*50 00	*50 00	.....	.....	*3,867	*5,000	*5,000	.....	.....	.....	.....
4	Rock Creek	*200	*10 00	*70 00	*80 00	*96.8	*2,001	*10,828	*14,000	*16,001	.....	.....	.....	.....
5	Tuscarora	9,721	15 15	144 31	159 46	7,124.3	147,272	1,085,032	1,402,837	1,550,109	8,721	12 12	115 45	127 87
6	White Rock	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7	Scattered	*1,200	*3 00	*60 00	*63 00	*174.1	*3,599	*55,689	*72,000	*75,599	*1,000	*1 84	*50 00	*51 84
	Total	13,221	11 71	122 82	134 53	7,492.0	154,873	1,255,965	1,623,837	1,778,710	11,721	9 31	99 27	108 58
	ESMERALDA.													
1	Alum Creek	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	Black Mountain	690	.....	91 88	91 88	.....	.....	49,037	63,400	63,400	690	.....	70 78	70 78
3	Cambridge	480	*20 44	*18	*20 62	*474.5	*9,809	*70	*90	*9,899	480	15 99	15	16 14
4	Columbus (a)	23,975	1 00	57 83	58 83	1,161.0	24,000	1,072,335	1,386,422	1,410,422	23,975	75	48 78	49 53
5	Dutchman Creek	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	Esmeralda	*250	*75 00	*25 00	*100 00	907.0	18,750	4,834	6,250	25,000	250	60 00	20 00	80 00
7	Gold Mountain	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	Lake	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9	Lida Valley	*200	*10 00	*80 00	*90 00	*96.8	*2,001	*12,375	*16,000	*18,001	*200	*7 50	*67 50	*75 00
10	Montezuma	*300	.....	*70 00	*70 00	.....	.....	*16,243	*21,000	*21,000	*300	.....	55 25	*55 25
11	Mount Grant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
12	Oneota	700	.....	113 00	113 00	.....	.....	61,189	79,100	79,100	348	.....	142 87	142 87
13	Palmetto	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	Santa Fé	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15	Silver Peak	300	*55 00	*55 00	*110 00	*798.2	*16,500	*12,762	*16,500	*33,000	300	45 39	46 51	91 90
16	Volcano	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	Washington	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	Wilson	2,836	30 98	50	32 48	4,388.4	90,716	1,095	1,416	92,132	2,818	28 59	23	26 82
	Total	29,731	5 44	53 49	58 93	7,825.9	161,776	1,229,931	1,590,178	1,751,954	29,361	4 45	44 88	49 33
	EUREKA.													
1	Cortez	505	.....	292 00	292 00	.....	.....	114,054	147,460	147,460	505	.....	243 67	243 67
2	Eureka (b)	81,307	19 40	37 14	56 54	76,304.5	1,577,354	2,333,634	3,019,742	4,597,096	78,807	16 49	33 43	49 92
3	Secret Cañon	201	.....	92 59	92 59	.....	.....	14,394	18,610	18,610	80	.....	*141 88	*141 88
	Total	82,013	19 23	38 84	58 07	76,304.5	1,577,354	2,464,082	3,185,812	4,763,166	79,392	16 37	34 68	51 25
	HUMBOLDT.													
1	Bradshaw	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	Buckskin	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	Buena Vista	1,000	6 00	34 00	40 00	290.3	6,001	26,297	34,000	40,001	*1,000	*4 50	*26 00	*30 50
4	Congo	20	.....	75 00	75 00	.....	.....	1,180	1,500	1,500	1	.....	63 00	63 00
5	Mount Rose	7,250	4 64	48 31	52 95	1,629.4	33,663	270,882	350,234	383,907	7,070	3 71	38 57	42 28
6	Rebel Creek	*200	*6 00	*54 00	*60 00	*58.1	*1,201	*8,254	*10,800	*12,001	*100	*5 00	*45 00	*50 00
7	Richmond	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	Sierra	2,973	18 00	.....	18 00	2,583.7	53,513	.....	.....	53,513	2,473	13 78	.....	13 78
9	Silver State	15	.....	170 00	170 00	.....	.....	1,973	2,550	2,550	.....	.....	.....	.....
10	Winnemucca	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	11,458	8 24	34 83	43 07	4,503.5	94,366	308,606	399,074	493,472	10,644	6 14	28 49	34 63
	LANDER.													
1	Lewis	3,600	.....	65 00	65 00	.....	.....	189,989	234,000	234,000	3,600	.....	47 22	47 22
2	Reese River	*4,568	.....	257 11	257 11	.....	.....	937,326	1,082,579	1,082,579	4,151	.....	226 43	226 43
	Total	8,168	.....	161 22	161 22	.....	.....	1,018,315	1,316,579	1,316,579	7,751	.....	143 19	143 19
	LINCOLN.													
1	Bristol	*7,209	.....	*50 00	*50 00	.....	.....	*278,789	*360,446	*360,446	*7,209	.....	*45 00	*45 00
2	Eldorado	270	7 50	55 00	62 50	98.0	2,026	11,486	14,850	16,876	270	6 44	47 23	53 67
3	Ely	6,920	2 43	59 82	62 25	812.9	16,804	320,191	413,975	430,779	2,919	19	58 28	58 47
	Total	14,399	1 31	54 81	56 12	910.9	18,830	610,466	789,271	808,101	10,398	23	48 78	49 00

*Estimated.

MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ozs.	Dolls.	Ounces.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	
78.3	1,620	82,450	106,600	108,220												1
					*100			*3,867	*5,000	*5,000						2
					*200	*66.8	*2,001	*10,828	*14,000	*16,001						3
5,113.1	105,697	778,805	1,006,917	1,112,614	*1,000	*732.9	*15,150	*111,617	*144,309	*159,453						4
																5
*39.0	*1,840	*38,673	*50,000	51,840	*200	*29.0	*600	*9,282	*12,000	*12,600						6
5,281.4	109,176	899,928	1,163,517	1,272,693	*1,500	*858.7	*17,751	*135,594	*175,309	*193,060						7
		37,776	48,841	48,841												1
371.3	7,675	58	75	7,750												2
870.7	18,000	904,608	1,169,568	1,187,568												3
													1,129	1,460	1,460	4
725.6	15,000	3,867	5,000	20,000												5
																6
																7
72.6	*1,500	*10,442	*13,500	15,000												8
		12,820	16,575	16,575												9
																10
		38,455	49,718	49,718	352			19,351	25,019	25,019						11
																12
																13
658.6	13,614	10,794	13,955	27,569												14
																15
																16
3,625.5	74,946	498	644	75,590	18	26.1	540	6	8	548						17
6,324.3	130,735	1,019,318	1,317,876	1,448,611	370	26.1	540	19,357	25,027	25,567			1,129	1,460	1,460	18
		95,176	123,053	123,053												
62,893.4	1,300,122	2,037,666	2,634,499	3,934,621	2,500	1 789.9	37,000	58,000	75,000	112,000						1
		8,779	11,350	11,350	121			4,680	6,051	6,051						2
62,893.4	1,300,122	2,141,621	2,768,902	4,069,024	2,621	1 789.9	37,000	62,680	81,051	118,051						3
*217.7	*4,500	30,110	*26,000	*30,500												1
		49	63	63	19			1,111	1,437	1,437						2
1,270.3	26,259	210,922	272,702	298,961	180	41.1	850	7,242	9,363	10,213						3
*24.2	*500	3,481	*4,500	*5,000	*100	*29.0	*500	*4,177	*5,460	*5,960						4
																5
1,648.5	34,078			34,078	*500	435.4	9,001			9,001						6
					15			1,972	2,550	2,550						7
																8
																9
3,160.7	65,337	234,562	303,265	368,602	814	505.5	10,450	14,502	18,750	29,200						10
		121,487	170,000	170,000												
		736,952	939,876	939,876	415			*76,108	*98,400	*98,400						1
		858,439	1,109,876	1,109,876	415			*76,108	*98,400	*98,400						2
		250,910	324,401	324,401												
84.1	1,739	9,864	12,753	14,492												1
27.2	562	131,581	170,122	170,684	4,001	774.2	16,004	154,730	200,050	216,054						2
111.3	2,301	392,355	507,276	509,877	4,001	774.2	16,004	154,730	200,050	216,054						3

* Estimated.

TABLE CXXIV.—NEVADA—PRODUCTION OF DEEP MINES

	County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	NYE.													
1	Ione													
2	Jet													
3	Lodi													
4	Lone Mountain													
5	Mammoth, or Ellsworth													
6	Morey	200	.....	90 00	90 00	.....	.....	13,922	18,000	18,000	200	.....	72 00	72 00
7	Philadelphia	700	.....	67 00	67 00	.....	.....	36,275	46,900	46,900	700	.....	44 80	44 80
8	San Antonio													
9	Silver Star	*600	.....	*60 00	*60 00	.....	.....	27,844	36,000	36,000	*600	.....	*50 00	*50 00
10	Sunnyside													
11	Tybo	7,800	4 00	28 00	32 00	1,509.3	31,200	168,923	218,400	249,600	7,800	3 36	23 56	26 92
12	Union	14,517	03	28 59	28 62	18.3	378	319,467	413,039	413,417	14,517	02	25 04	25 06
	Total	23,817	1 33	30 75	32 08	1,527.6	31,578	566,431	732,339	763,917	23,817	1 11	26 16	27 27
	STOREY AND LYON.													
1	The Comstock	155,986	21 78	26 49	48 27	164,350.1	3,397,418	3,196,575	4,132,851	7,530,269	155,986	16 83	19 87	36 20
2	Scattered	*5,714½	*21 00	*25 66	*46 66	5,805.0	*120,000	113,440	*146,667	*266,667	*5,714½	*15 75	*19 25	*35 00
	Total	161,700½	21 75	26 47	48 22	170,155.1	3,517,418	3,310,015	4,279,518	7,796,936	161,700½	16 31	19 85	36 16
	WHITE PINE.													
1	Cherry Creek	877	1 04	68 11	69 15	294.9	6,096	309,609	400,294	406,390	5,877	83	58 57	59 40
2	Ward	5,393	.....	53 32	53 32	.....	.....	222,411	287,555	287,555	5,393	.....	42 54	42 54
3	White Pine	277	.....	59 91	59 91	.....	.....	12,847	16,610	16,610	277	.....	47 93	47 93
	Total	11,547	53	61 00	61 53	294.9	6,096	544,867	704,459	710,555	11,547	42	50 83	51 25

* Estimated.

(a) From 31 tons raised prior to census year.

TABLE CXXV.—NEVADA—RECAPITULATION BY COUNTIES OF

	County.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
1	Elko	13,221	11 71	122 82	134 53	7,492.0	154,873	1,255,965	1,623,837	1,778,710	11,721	9 31	99 27	108 58
2	Esmeralda	29,731	5 44	53 49	58 93	7,825.9	161,776	1,229,931	1,590,178	1,751,954	29,361	4 45	44 88	49 33
3	Eureka	82,013	19 23	38 84	58 07	76,304.5	1,577,354	2,464,082	3,185,812	4,763,166	79,392	16 87	34 88	51 25
4	Humboldt	11,458	8 24	34 83	43 07	4,566.5	94,398	308,666	399,074	493,472	10,644	6 14	28 49	34 63
5	Lander	8,166	.....	161 22	161 22	.....	.....	1,018,315	1,316,579	1,316,579	7,751	.....	143 19	143 19
6	Lincoln	14,399	1 31	54 81	56 12	910.9	18,830	610,466	789,271	808,101	10,398	22	48 78	49 00
7	Nye	23,817	1 33	30 75	32 08	1,527.6	31,578	566,431	732,339	763,917	23,817	1 11	26 16	27 27
8	Storey and Lyon	161,700½	21 75	26 47	48 22	170,155.1	3,517,418	3,310,015	4,279,518	7,796,936	161,700	16 31	19 85	36 16
9	White Pine	11,547	53	61 00	61 53	294.9	6,096	544,867	704,459	710,555	11,547	42	50 83	51 25
	Total	356,052½	15 62	41 06	56 68	269,077.4	5,562,323	11,308,738	14,621,067	20,183,390	346,331	12 35	33 47	45 82

FOR THE YEAR ENDING MAY 31, 1880—Continued.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ozs.	Dolls.	Ounces.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	
																1
																2
																3
																4
		11,138	14,400	14,400												5
		24,255	31,380	31,380									6,932	8,962	8,962	6
																7
		23,204	30,000	30,000												8
																9
1,267.8	26,208	142,155	183,792	210,000												10
16.2	335	281,131	363,474	363,809												11
1,284.0	26,543	481,883	623,026	649,569									6,932	8,962	8,962	12
123,262.6	2,548,064	2,397,432	3,099,639	5,647,703							*27,142.6	*561,087	*551,886	*713,535	*1,274,622	1
*4,353.8	*90,001	*85,080	*110,000	*200,001												2
127,616.4	2,638,065	2,482,512	3,209,639	5,847,704							*27,142.6	*561,087	*551,886	*713,535	*1,274,622	
235.9	4,877	266,222	344,199	349,076												1
		177,444	229,418	229,418												2
		10,278	13,288	13,288									89,721	116,000	116,000	3
235.9	4,877	453,944	586,905	591,782									89,721	116,000	116,000	

*Estimated.

(b) About one-half the product of Eureka district is calculated from statements covering a fiscal year ending four months later than the census year. This does not materially impair the accuracy of the figures quoted, as the output for the district is remarkably steady.

PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ozs.	Dolls.	Ounces.	Dollars.	Dollars.	Ounces.	Dollars.	Ozs.	Dollars.	Dollars.	
5,281.4	109,176	899,928	1,163,517	1,272,693	*1,500	*858.7	*17,751	*135,594	*175,309	*193,060						1
6,324.3	130,735	1,019,318	1,317,876	1,448,611	370	26.1	540	19,357	25,027	25,567			1,129	1,460	1,460	2
62,893.4	1,300,122	2,141,621	2,768,902	4,069,024	2,621	1,789.9	37,000	62,689	81,051	118,051						3
3,160.7	65,337	234,562	303,265	368,602	814	505.5	10,450	14,502	18,750	29,200						4
		858,439	1,109,876	1,109,876	415			*76,108	*98,400	*98,400						5
111.3	2,301	392,355	507,276	509,577	4,001	774.2	16,004	154,730	200,050	216,054						6
1,284.0	26,543	481,883	623,026	649,569									6,932	8,962	8,962	7
127,616.4	2,638,065	2,482,512	3,209,639	5,847,704							27,142.6	*561,087	551,886	*713,535	*1,274,622	8
235.9	4,877	453,944	586,905	591,782									89,721	116,000	116,000	9
268,907.4	4,277,156	8,964,562	11,590,282	15,867,438	9,721	3,954.4	81,745	462,980	598,587	680,332	27,142.6	*561,087	649,608	*839,957	*1,401,044	

*Estimated.

TABLE CXXVI.—PRODUCTION OF LEADING COMSTOCK MINES.

Month.	Consolidated Virginia mine.		California mine.		*Union Consolidated mine.				†Ophir mine.				‡Sierra Nevada mine.
	Ore milled.	Bullion produced.	Ore milled.	Bullion produced.	Ore milled.	Bullion produced.			Ore milled.	Bullion produced.			Bullion shipped.
						Gold.	Silver.	Total.		Gold.	Silver.	Total.	
1879.	*Tons.*	*Dollars.*	*Tons.*	*Dollars.*	*Tons.*	*Dollars.*	*Dollars.*	*Dollars.*	*Tons.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
June	3,466.5	127,007 81	5,193.5	185,963 10	.....	.....	.....	.....	1,311.45	30,984 47	42,992 78	73,957 25	60,386 77
July	4,745.5	189,303 08	4,454.5	108,739 63	.....	.....	.....	.....	1,529.00	55,711 69	52,879 03	108,590 72	101,860 94
August	4,730.0	160,215 03	4,411.0	101,107 73	.....	.....	.....	.....	1,716.00	40,196 29	48,430 40	88,626 69	45,347 78
September	4,072.0	109,020 81	4,228.0	124,605 78	.....	.....	.....	.....	1,730.00	41,277 79	55,094 46	96,372 25	.....
October	4,113.0	158,476 52	3,573.0	67,840 37	.....	.....	.....	.....	1,496.75	49,238 37	66,615 58	115,853 95	.....
November	4,850.0	198,359 56	4,141.0	125,772 28	.....	.....	.....	.....	1,536.65	41,184 14	61,735 28	102,919 42	.....
December	4,674.0	169,503 65	3,526.0	191,265 77	3,200.75	144,965 25	132,318 38	277,283 63	1,346.65	18,633 86	28,813 41	48,446 27	.....
1880.													
January	5,209.0	194,222 13	5,391.0	164,106 71	3,336.00	61,223 69	54,493 93	115,717 62	1,638.00	26,343 42	34,323 27	60,666 69	14,545 23
February	4,230.0	128,168 72	2,220.0	39,930 92	4,750.00	98,027 23	98,895 07	197,322 30	1,609.00	27,308 61	31,343 49	58,747 10	31,843 85
March	4,338.0	151,396 01	1,168.0	28,411 80	9,003.15	169,219 89	191,586 91	360,806 80	951.80	7,929 29	10,683 11	18,612 40	.....
April	4,607.5	173,642 25	2,492.5	60,004 76	5,015.88	61,125 47	91,166 17	152,291 64	755.20	8,688 19	10,347 98	19,036 17	.....
May	5,890.5	205,778 01	2,169.5	55,334 54	2,713.22	31,004 06	39,877 26	70,881 32	228.55	3,950 60	5,028 04	8,978 64	.....
Total	54,894.0	1,965,083 58	42,968.0	1,253,023 39	30,019.00	566,465 59	608,337.72	1,174,803 31	15,890.05	352,516 72	448,290 83	800,807 55	253,986 60

*Milled at the Brunswick and Morgan mills. †All treated at the Trench mill. ‡All ore during census year treated at Mariposa mill.

PLACER MINES.—The placer yield of Nevada is insignificant. No important gravel deposits having suitable water supply are known to exist. The ground worked is in most cases merely the wash from the croppings of quartz veins. Operations are conducted on a small scale at Tuscarora, Tulé Cañon, points in the neighborhood of the Comstock, and in a few other isolated spots. The aggregate yield for the year is estimated roundly at $50,000.

CORRELATIVE STATISTICS.—There is a state bullion tax in Nevada, but in no other state or territory. The assessor's rolls, prepared in collecting this tax, furnish interesting comparative data, which have been condensed into the following abstracts. The periods selected for comparison correspond with the United States fiscal year (ending June 30, 1880). The discrepancies between the census figures and those obtained from the assessor's rolls are mainly due to the natural undervaluation attending the collection of information for the purpose of taxation, and the escape of many small amounts from enrollment altogether; and in a less degree to the fact that the United States fiscal year is one month later than the census year.

TABLE CXXVII.—TAXED PRODUCT OF THE NEVADA MINES.

[From reports of the state controller, containing abstract statements of the quarterly assessment rolls for the years 1879 and 1880.]

County.		THIRD QUARTER, 1879.				FOURTH QUARTER, 1879.			
		Quantity worked.		Gross yield or value.	Net yield or value on which tax is levied.	Quantity worked.		Gross yield or value.	Net yield or value on which tax is levied.
		Tons.	Pounds.			Tons.	Pounds.		
Elko	Ores	5,872	.....	$454,558 96	$288,755 12	3,397	960	$164,462 76	$41,601 99
Esmeralda	do	5,319	1,138	209,637 60	29,300 81	6,177	1,032	279,686 39	122,047 18
Eureka	do	25,263	196	902,679 81	304,900 09	23,015	700	822,196 79	278,981 76
Humboldt	do	2,465	.....	58,066 00	18,644 41	4,223	128	134,051 67	55,264 23
Lander	do	1,766	1,297	178,380 13	60,873 51	1,351	1,653	122,927 18	52,218 92
Lincoln	do	5,724	1,758	158,277 02	36,366 24	4,455	479	125,579 37	23,883 27
Nye	do	5,648	94	145,281 18	6,655 00	6,676	1,371	194,597 64	37,816 51
Storey	do	34,819	1,000	1,130,145 54	376,063 96	41,148	250	1,568,328 30	656,542 12
White Pine	do	7,620	682	242,565 50	67,306 93	1,197	1,250	60,953 61	7,362 07
Total ores		93,919	165	3,479,011 14	1,197,886 07	91,643	1,833	3,487,763 71	1,285,718 10
Humboldt	Tailings	560	.....	3,100 00	600 00	780	.....	3,400 00	675 00
Lyon	do	6,733	.....	28,724 80	5,449 87	7,635	.....	32,961 90	11,901 80
Ormsby	do	29,206	.....	251,837 11	123,894 66	16,410	.....	160,056 78	63,852 33
Storey	do	15,355	.....	126,022 40	37,776 68	6,806	.....	24,628 40	8,514 88
White Pine	do	3,267	.....	11,996 02	2,788 42	7,069	.....	32,365 68	5,089 68
Total tailings		55,121	.....	421,630 22	170,509 63	38,700	.....	290,812 76	90,033 69

TABLE CXXVII.—TAXED PRODUCT OF THE NEVADA MINES—Continued.

County.		FIRST QUARTER, 1880.				SECOND QUARTER, 1880.			
		Quantity worked.		Gross yield or value.	Net yield or value on which tax is levied.	Quantity worked.		Gross yield or value.	Net yield or value on which tax is levied.
		Tons.	Pounds.			Tons.	Pounds.		
Elko	Ores	1,500	.....	$95,739 75	$32,245 90	1,556	1,500	$51,457 51	$7,683 01
Esmeralda	do	7,262	607	278,877 05	115,280 06	8,681	.....	277,085 63	80,853 08
Eureka	do	23,532	1,644	885,768 91	304,197 11	20,944	166	891,492 12	329,038 32
Humboldt	do	3,411	200	97,408 00	35,724 38	4,111	271	82,343 15	23,678 52
Lander	do	1,472	1,942	138,433 14	53,923 76	1,251	806	140,188 20	58,971 79
Lincoln	do	2,321	1,623	64,226 18	7,853 72	1,440	1,510	50,679 26	9,512 22
Nye	do	6,155	1,430	122,864 72	9,758 67	5,509	270	128,328 82	12,580 05
Storey	do	49,113	1,350	1,619,620 07	580,987 68	38,846	.....	1,138,971 16	372,826 33
White Pine	do	1,101	750	55,059 90	9,628 20	1,951	1,511	61,253 30	6,446 24
Total ores		95,871	1,546	3,358,197 72	1,148,599 48	83,692	134	2,822,799 25	901,589 57
Humboldt	Tailings	360	.....	2,909 00	840 00	2,496	30	18,629 00	8,565 26
Lincoln	do	150	.....	1,050 00	105 00	804	225	8,469 79	1,178 79
Lyon	do	25,754	.....	101,435 77	17,432 48	23,946	.....	134,432 37	38,200 78
Ormsby	do	7,912	.....	66,722 81	27,698 01	13,185	.....	112,440 38	44,115 19
Storey	do	.....	.....	.....	.....	6,179	.....	43,341 45	10,311 13
White Pine	do	5,606	.....	21,585 51	2,156 55	7,630	.....	24,420 22	2,442 00
Total tailings		40,074	.....	193,704 09	48,229 04	82,700	255	341,733 21	104,813 15

Summary of the taxed product of the Nevada mines.

County.		Quantity worked.		Gross yield or value.	Net yield or value on which tax is levied.
		Tons.	Pounds.		
Elko	Ores	12,326	460	$766,216 98	$300,296 02
Esmeralda	do	27,440	777	1,045,566 07	357,481 13
Eureka	do	92,775	706	3,502,137 63	1,217,117 29
Humboldt	do	14,210	709	371,888 82	133,311 59
Lander	do	5,842	1,698	579,928 75	234,967 98
Lincoln	do	13,942	1,370	396,761 83	77,615 45
Nye	do	23,989	1,165	581,072 36	66,810 23
Storey	do	163,927	600	5,482,265 07	1,905,420 09
White Pine	do	10,671	193	419,932 81	90,743 44
Total ores		365,125	1,678	13,147,771 82	4,533,773 22
Humboldt	Tailings	4,396	30	28,029 00	10,680 26
Lincoln	do	1,014	225	9,519 79	1,283 79
Lyon	do	62,088	.....	365,954 73	72,984 93
Ormsby	do	66,713	.....	571,067 08	229,555 19
Storey	do	28,340	.....	209,992 25	56,602 60
White Pine	do	23,664	.....	91,307 43	12,478 65
Total tailings		186,595	255	1,207,870 28	413,585 51

UTAH.

The bullion product of Utah is remarkably steady, varying latterly but little from year to year. This territory presents facilities for arriving at a true valuation of the product which are wanting in many other mining localities. The mines are more concentrated, the yield coming from a comparatively few but rich claims, and the bulk of the ore is treated by a few large smelting works and mills, where accurate accounts are kept. It is therefore easier to collect full statistics of the product than in regions where the bullion is derived from a vast number of sources, each one of which furnishes only a small quota, as is the case where placer-mining forms an important factor. The census figures for Utah are also the more reliable from the fullness and clearness with which the schedules were prepared by the special expert for the territory.

The tabulation of the product is based on returns from 535 deep mines, 1 placer mine, 18 amalgamating mills, 34 smelting works, and 10 miscellaneous metallurgical establishments, consisting of sampling, concentration, and leaching works. Many of these sources were, however, unproductive during the census year.

Table CXXVIII shows the amount of ore raised in the several districts, with the bullion product, so far as traceable by districts. The table includes a statement of ore sold, with the price. The larger part of the bullion here stated is from milling ores. The silver-lead ores sold to the smelters are in many cases transported for reduction out of the district in which they were raised; and as their identity is lost in the mixture of ores from all portions of the territory, and even from other states and territories, it is impossible to segregate the bullion yield by districts.

TABLE CXXVIII.—UTAH—PRODUCTION OF DEEP MINES

[Ore raised is stated in gross tons. The assay value is of the net tons.

	County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated (in same district).	Average yield per ton.		
			Gold.	Silver.	Gold and Silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and Silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	BEAVER.													
1	Bradshaw	1,771.75	4 81	22 25	27 06	412.4	8,525	30,497	39,430	47,955	1,771.75	4 81	18 03	22 84
2	San Francisco (a)	16,994.00	.....	50 04	50 04	.....	.....	657,730	850,379	850,379	16,244.00	.....	39 22	39 22
3	Star	900.00	.....	5 00	5 00	.....	.....	3,481	4,500	4,500	.....	.....	.....	.....
	Total	19,665.75	43	45 47	45 90	412.4	8,525	691,708	894,309	902,834	18,015.75	42	37 14	37 56
	JUAB.													
1	Tintic	6,256.00	15 05	38 60	53 65	4,554.3	94,146	186,805	241,520	335,666	3,548.00	16 98	3 15	20 13
	Total	6,256.00	15 05	38 60	53 65	4,554.3	94,146	186,805	241,520	335,666	3,548.00	16 98	3 15	20 13
	PIUTE.													
1	Mount Baldy	130.00	40 72	105 92	146 64	256.1	5,294	10,650	13,770	19,064	.....	.....	.....	.....
	Total	130.00	40 72	105 92	146 64	256.1	5,294	10,650	13,770	19,064	.....	.....	.....	.....
	SALT LAKE.													
1	Big Cottonwood (b)	1,575.50	.....	72 34	72 34	.....	.....	88,150	113,969	113,969	.....	.....	.....	.....
2	Little Cottonwood (c)	6,324.50	1 39	57 73	59 12	426.2	8,810	282,276	365,084	373,894	.....	.....	.....	.....
3	West Mountain (gold mines)	12,000.00	11 58	1 75	13 33	6,724.1	138,999	16,343	21,001	160,000	12,000.00	9 69	53	10 22
4	West Mountain (silver-lead mines) (d)	32,606.00	45	17 80	17 95	715.4	14,789	441,222	570,456	585,245	.....	.....	.....	.....
	Total	52,506.00	3 09	20 39	23 48	7,865.7	162,598	827,991	1,070,510	1,233,108	12,000.00	9 69	53	10 22
	SUMMIT.													
1	Uinta	16,918.33	.....	126 12	126 12	.....	.....	1,650,400	2,133,802	2,133,802	12,508.00	.....	97 04	97 04
2	.....do	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	16,918.33	.....	126 12	126 12	.....	.....	1,650,400	2,133,802	2,133,802	12,508.00	.....	97 04	97 04
	TOOELE.													
1	Camp Floyd	1,400.00	.....	19 00	19 00	.....	.....	20,574	26,600	26,600	200.00	.....	37 50	37 50
2	Ophir (f)	1,887.20	.....	156 08	156 08	.....	.....	227,826	294,556	294,556	50.00	.....	20 00	20 00
3	Rush Valley (f)	4,032.00	.....	23 80	23 80	.....	.....	74,230	95,972	95,972	.....	.....	.....	.....
	Total	7,319.20	.....	56 99	56 99	.....	.....	322,630	417,128	417,128	250.00	.....	34 00	34 00
	UTAH.													
1	American Fork	1,836.50	.....	28 73	28 73	.....	.....	40,810	52,763	52,763	.....	.....	.....	.....
2	Silver Lake (g)	121.00	....	74 99	74 99	.....	.....	7,018	9,074	9,074	.....	.....	.....	.....
	Total	1,957.50	.....	31 59	31 59	.....	.....	47,828	61,837	61,837	.....	.....	.....	.....
	WASHINGTON.													
1	Harrisburg, or Silver Reef	49,895.00	.....	26 71	26 71	.....	.....	1,030,744	1,332,649	1,332,649	46,795.00	.....	21 66	21 66
	Total	49,895.00	.....	26 71	26 71	.....	.....	1,030,744	1,332,649	1,332,649	46,795.00	.....	21 66	21 66
1	Scattered	*180.00	.....	*77 57	*77 57	.....	.....	*10,800	*13,963	*13,963	.....	.....	.....	.....

* Estimated.
a Moisture 3 per cent.
b Moisture 7½ per cent.
c Moisture 10 per cent.
d Moisture 6½ per cent.
f Moisture 7 per cent.
g Moisture 8 per cent.

TABLE CXXIX.—UTAH—RECAPITULATION BY COUNTIES OF

	County.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated in the same counties.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
1	Beaver	19,665.75	43	45 47	45 90	412.4	8,525	691,708	894,309	902,834	18,015.75	42	37 14	37 56
2	Juab	6,256.00	15 05	38 60	53 65	4,554.3	94,146	186,805	241,520	335,666	3,548.00	16 98	3 15	20 13
3	Piute	130.00	40 72	105 92	146 64	256.1	5,294	10,650	13,770	19,064	.....	.....	.....	.....
4	Salt Lake	52,506.00	3 09	20 39	23 48	7,865.7	162,598	827,991	1,070,510	1,233,108	12,000.00	9 69	53	10 22
5	Summit	16,918.33	.....	126 12	126 12	.....	.....	1,650,400	2,133,802	2,133,802	12,508.00	.....	97 04	97 04
6	Do	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7	Tooele	7,319.20	.....	56 99	56 99	.....	.....	322,630	417,128	417,128	250.00	.....	34 00	34 00
8	Utah	1,957.50	.....	31 59	31 59	.....	.....	47,828	61,837	61,837	.....	.....	.....	.....
9	Washington	49,895.00	.....	26 71	26 71	.....	.....	1,030,744	1,332,649	1,332,649	46,795.00	.....	21 66	21 66
10	Scattered	*180.00	.....	*77 57	*77 57	.....	.....	*10,800	*13,963	*13,963	.....	.....	.....	.....
	Total (a)	154,827.78	1 75	39 91	41 66	13,088.5	270,563	4,779,556	6,179,488	6,450,051	93,116.75	1 96	31 38	33 36

* Estimated.
a Including only the product which could be segregated by counties. The balance, not thus traceable, is added in the recapitulation for the United States, bringing the corresponding figures up to $270,045 gold, $4,506,954 silver, and $4,666,999 total.

FOR THE YEAR ENDING MAY 31, 1880.

Percentage of moisture is attached to each district where important.]

Bullion produced from ore raised and treated during census year, as traced by districts.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.					Ore sold.	Cash receipts for ore sold. (Bullion accounted for in returns of smelting works.)		
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.		Aver'ge price per ton.	Total receipts.	
Ozs.	Dolls.	Ounces.	Dollars.	Dollars.	Tons.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Tons.	Dolls.	Dolls.	
369.5	7,638	24,703	31,939	39,577							74.6	1,543	4,994	6,444	7,988				1
		492,760	637,089	637,089	750			30,000	38,787	38,787									2
																900.00	8 00	7,200	3
369.5	7,638	517,463	669,028	676,666	750			30,000	38,787	38,787	74.6	1,543	4,994	6,444	7,988	900.00	8 00	7,200	
2,914.0	60,238	8,663	11,200	71,438	450	135.5	2,801	5,200	6,800	9,601						2,258.00	45 11	102,800	1
2,914.0	60,238	8,663	11,200	71,438	450	135.5	2,801	5,200	6,800	9,601						2,258.00	45 11	102,800	
					50			1,547	2,000	2,000						80.00	98 06	7,845	1
					50			1,547	2,000	2,000						80.00	98 06	7,845	
																1,875.50	53 87	84,881	1
																6,254.50	47 65	301,395	2
5,627.4	116,329	4,880	6,309	122,638															3
					2,650	29.0	600	28,500	34,262	34,862						28,956.00	15 86	475,513	4
5,627.4	116,329	4,880	6,309	122,638	2,650	29.0	600	28,500	34,262	34,862						37,856.00	22 76	861,789	
		938,702	1,213,725	1,213,725	3,845			370,269	478,720	478,720			107,911	139,518	139,518	565.33	43 13	7,420	1
																300.00	40 00	a12,000	2
		938,702	1,213,725	1,213,725	3,845			370,269	478,720	478,720			107,911	139,518	139,518	865.33	53 13	19,420	
		5,801	7,500	7,500	1,200			12,839	16,600	16,600									1
		774	1,001	1,001												1,837.20	123 27	226,473	2
																4,032.00	17 23	69,475	3
		6,575	8,501	8,501	1,200			12,839	16,600	16,600						5,869.20	50 42	295,947	
					100			3,867	5,000	5,000						1,736.50	27 90	48,450	1
																121.00	55 25	6,685	2
					100			3,867	5,000	5,000						1,857.50	29 63	55,135	
		784,065	1,013,718	1,013,718	3,100			57,227	73,989	73,989									1
		784,065	1,013,718	1,013,718	3,100			57,227	73,989	73,989									
																*180.00	*60 00	*10,800	1

* Estimated.

a For 300 tons of concentrations from 5,100 tons tailings.

PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year, as traced by counties.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.					Ore sold.	Cash receipts for ore sold. (Bullion accounted for in returns of smelting works.)		
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.		Aver'ge price per ton.	Total receipts.	
Ozs.	Dolls.	Ounces.	Dollars.	Dollars.	Tons.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Tons.	Dolls.	Dolls.	
369.5	7,638	517,463	669,028	676,666	750			30,000	38,787	38,787	74.6	1,543	4,994	6,444	a7,988	900.00	8 00	7,200	1
2,914.0	60,238	8,663	11,200	71,438	450	135.5	2,801	5,200	6,800	9,601						2,258.00	45 11	102,800	2
					50			1,547	2,000	2,000						80.00	98 06	7,845	3
5,627.4	116,329	4,880	6,309	122,638	2,650	29.0	600	28,500	34,262	34,862						37,856.00	22 76	861,789	4
		938,702	1,213,725	1,213,725	3,845			370,269	478,720	478,720			107,911	139,518	139,518	565.33	13 13	7,420	5
																300.00	40 00	b12,000	6
		6,575	8,501	8,501	1,200			12,839	16,600	16,600						5,869.20	50 42	295,947	7
					100			3,867	5,000	5,000						1,857.50	29 63	55,135	8
		784,065	1,013,718	1,013,718	3,100			57,227	73,989	73,989									9
																*180.00	*60 00	*10,800	10
8,910.9	184,205	2,200,408	2,922,481	3,106,686	12,145	164.5	3,401	507,509	656,158	659,559	74.6	1,543	112,896	145,962	147,504	49,986.03	27 29	1,360,996	

* Estimated.

a From 357.5 tons raised prior to census year.

b For 300 tons concentrations.

In Table CXXVIII, and in the one following, Table CXXIX, which gives the yield by counties, the ore is stated in gross tons, and the assay value and yield is of net tons, the amount of moisture being noted in the district table where important. The following is an exhibit of the proportionate amounts of ore milled and ore smelted:

TABLE CXXX.—UTAH—STATEMENT OF ORE MILLED AND SMELTED.

County.	District.	Ore milled.	Ore smelted.	Total ore treated.	Percentage of ore milled.	Percentage of ore smelted.
		Tons.	Tons.	Tons.		
Beaver	Bradshaw		1,771.75			100
Do	San Francisco		16,244.00			100
Do	Star		900.00	18,915.75		100
Juab	Tintic	3,848	2,258.00	5,806.00	61	39
Piute	Mount Baldy		80.00	80.00		100
Salt Lake	Big Cottonwood		1,875.50			100
Do	Little Cottonwood		6,324.50			100
Do	West Mountain (gold mines)	13,000			100	
Do	West Mountain (silver-lead mines)		20,956.00	40,898.00		100
Summit	Uinta	13,508	565.33	13,973.33		100
Tooele	Camp Floyd	200			100	
Do	Ophir	80	1,837.20		3	97
Do	Rush Valley		4,032.00	6,119.20		100
Utah	American Fork		1,736.50			100
Do	Silver Lake		121.00	1,857.50		100
Washington	Harrisburg or Silver Reef	48,795		48,795.00	100	
Scattered			180.00	180.00		100
Total		79,101	67,561.78	142,662.78	53	47

The most noticeable feature shown in the foregoing table is the large proportion of milling ore which Utah furnishes, compared with her base ores, although a territory generally supposed to be dependent upon her smelting works. It should be noted, also, that of the ore smelted there was a considerable amount which might have been treated by amalgamation, but which, because of the absence of proper milling facilities, or because of unusual richness, it was advisable to sell to the smelters. But while the percentage by weight of ore milled was 53 per cent., as against 47 per cent. for ores smelted, the same proportion does not hold with regard to value, the percentage of bullion extracted being only 51.08 per cent. for the product of amalgamating mills, as against 48.92 per cent. for that from the smelting works—a nearly even ratio. This difference is accounted for by the fact, that as a rule, the ores smelted, on account of the greater expense usually involved, are richer than the ores which will bear the milling expense, and also because of the higher proportion of the assay contents of the ore extracted by the smelting process, as compared with the milling results. The following analysis of the total bullion product of the territoy shows the relative amounts coming from each source:

TABLE CXXXI.—UTAH—ANALYSIS OF PRODUCT.

Classification of source.	Gold.	Silver.	Total.
Amalgamating mills, from ore raised during census year	$175,034	$2,247,009	$2,422,039
Amalgamating mills, from ore raised prior to census year		139,518	139,518
Total from mills	175,034	2,386,527	2,561,551
Smelting-works, from ore raised during census year	94,989	2,349,948	2,444,937
Smelting-works, from ore raised prior to census year	1,542	6,444	7,986
Total from smelting-works	96,531	2,356,392	2,452,923
Total from mills and smelting-works	271,565	4,742,919	5,014,474
Placer mines	20,000		20,000
Total	291,565	4,742,919	5,034,474

The average product of the Utah milling ores and ores smelted, and the average yield of all the Utah ore reduced by either process during the census year, was as follows:

TABLE CXXXII.—UTAH—COMPARATIVE RESULTS OF TREATMENT.

Metal.	Average yield of—		
	Ores milled.	Ores smelted.	All ore treated.
Gold, per ton	$2 33	$1 40	$1 90
Silver, per ton	29 92	34 78	33 24
Total	32 25	36 18	35 14

The next table shows the base bullion product of the Utah smelting works, with the precious-metal contents. It includes the yield of ores sent from Idaho, Montana, and Nevada to the Utah smelters, and also the product of a small quantity of ore which was raised prior to the census year.

TABLE CXXXIII.—UTAH—BASE BULLION PRODUCTION OF SMELTING WORKS FOR THE YEAR ENDING MAY 31, 1880.

County.	Refined lead.	Crude bullion, including weight of silver and gold contents.	Precious metals contained in base bullion.				
			Gold.		Silver.		Total.
	Pounds.	Pounds.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
Beaver	.....	8,312,937	444.1	9,180	522,447	675,472	684,652
Salt Lake	2,566,370	16,781,778	3,731.4	77,135	1,150,589	1,486,235	1,563,370
Tooele	.....	3,118,766	335.9	6,944	131,676	170,202	177,146
Total	2,566,370	28,213,501	4,511.4	93,259	1,813,906	2,345,199	2,438,458

Deducting from the crude bullion product 322,170 pounds, produced from Idaho, Montana, and Nevada ores smelted in Utah, the remainder, 27,891,331 pounds, is the yield of Utah ores smelted in the Territory. To this should be added 865,500 pounds of crude lead bullion, the estimated yield of Utah ores smelted in Chicago and in Omaha. The total crude bullion product of Utah for the census year is, therefore, 28,756,831 pounds.

The gross precious metal product of the Utah smelting works, given in the preceding table, is segregated as follows:

TABLE CXXXIV.—UTAH—PRODUCT OF ORES SMELTED IN UTAH DURING CENSUS YEAR.

Product.			Gold bullion.		Silver bullion.		Total.
			Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
Product of smelting works (precious metals contained in base bullion)			4,511.4	93,259	1,813,906	2,345,199	2,438,458
Deduct product of Beaver county smelting works (accounted for in Table VIII)			444.1	9,180	522,447	675,472	684,652
Product of smelting works, less product of Beaver county smelting works			4,067.3	84,079	1,291,459	1,669,727	1,753,806
From this deduct:	*Ounces.*	*Dollars.*					
Product of Nevada ores smelted in Utah (a)	14,904	a19,392	.....	.....	.....	.....	.....
Product of Idaho ores smelted in Utah (b)	16,916	b21,871	.....	.....	.....	.....	.....
Product of Montana ores smelted in Utah (c)	5,116	c6,614	.....	.....	.....	.....	.....
Product of Nevada sulphides from leaching works	15,469	20,000	.....	.....	.....	.....	.....
Total	52,405	67,871	.....	.....	52,405	67,871	67,871
Net product of Utah ores smelted in Utah during census year			4,067.3	84,079	1,238,964	1,601,856	1,685,935

a 359 tons containing 25 per cent. lead. Estimated product, 89.775 tons lead.
b 162 tons containing 45 per cent. lead. Estimated product, 65.610 tons lead.
c 49 tons containing 30 per cent. lead. Estimated product, 14.700 tons lead.

In addition to the bullion product from ores which were treated in the territory, there was also a considerable yield from ores and matte shipped to Chicago and to Omaha and reduced at these points. As nearly as ascertainable this additional product was as follows:

TABLE CXXXV.—UTAH—BULLION PRODUCED FROM UTAH ORES AND MATTE, TREATED ELSEWHERE THAN IN THE TERRITORY.

Ores and matte shipped to Chicago and Omaha.	Assay value per ton.			Total assay value.					Estimated yield per ton.			Estimated product, to be included in total production of Utah.					Remarks.
	Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.	Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.	
Tons.	Dolls.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	
1,180	1 63	54 44	56 07	93	1,922	49,689	64,243	66,165	1 49	49 00	50 49	83.7	1,730	44,730	57,819	59,549	Containing 865,500 lbs. lead.
241	.....	64 64	64 64	.....	.....	13,050	15,579	15,579	.....	61 41	61 41	.....	.....	11,448	14,801	14,801	Containing 96,400 lbs. copper.
1,421	.....	.....	.....	93	1,922	61,739	79,822	81,744	.....	.....	.....	83.7	1,730	56,168	72,620	74,350	

From the preceding tables the following *résumé* is derived:

TABLE CXXXVI.—RÉSUMÉ.

Classification of product.	Bullion.				
	Gold.		Silver.		Total.
	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
Bullion product traceable by districts from Utah ore raised during census year	8,010.9	184,205	2,260,408	2,922,481	3,106,686
Bullion product traceable by districts from Utah ore raised prior to census year	74.6	1,542	112.895	145,902	147,504
Net bullion product from Utah ores sold to and treated by Utah smelting works during census year	4,067.3	84,079	1,238,964	1,601,857	1,685,936
Estimated bullion product of ores and matte shipped to Chicago and Omaha during census year	83.7	1,730	56,168	72,620	74,350
Product of placer mines (of West Mountain district, Salt Lake county) during census year	967.5	20,000	.....	.....	20,000
Total	14,104.0	291,556	3,668,435	4,742,920	5,034,476

UTAH PLACER GOLD.—The small placer product of the territory ($20,000 in the census year) was from West Mountain district, in Salt Lake county.

MARKET VALUE OF UTAH BASE BULLION.—The gold and silver contents of the base bullion are sold at a price which allows for the refining charge on each metal, with, of course, the market discount on the silver. Thus the gold contents brought from $19 to $20 per ounce, and the silver an average of $1 10 per ounce during the census year.

The average price of refined lead at Salt Lake City during the same period was 4¾ cents per pound, and that of unrefined lead $47 50 per ton.

Market value of 2,586,370 pounds refined lead	$122,853
Market value of 28,756,831 pounds unrefined lead	682,975
Total	805,828

This represents roughly the value at the seaboard after deducting freight charges, commissions, etc. There were also $14,160 worth of copper sold, the product of Utah ores worked for the extraction of the precious metals. Adding the market value of the lead and copper, all of it an accessory product of the precious-metal industries, to the mint value of the precious metals, the total product of the Utah mines is raised to $5,854,462. This does not include the value of iron ore sold for flux, and some other small items.

WELLS, FARGO & CO.'S ESTIMATES OF THE UTAH BULLION PRODUCT.—By way of comparison, the following estimates of the Utah bullion product, furnished by Mr. J. E. Dooly, agent of Wells, Fargo & Co., at Salt Lake City, are appended. They are for the calendar years 1879 and 1880.

TABLE CXXXVII.—WELLS, FARGO & CO.'S STATEMENT OF THE MINERAL PRODUCT OF UTAH FOR 1879.

Base bullion.	Lead, refined.	Lead, unrefined.	Silver.	Gold.
	Pounds.	*Pounds.*	*Ounces.*	*Ounces.*
Chicago smelter	.....	1,738,138	90,008	270
Germania smelting and refining works	2,301,276	.....	344,536	2,323
Horn silver mine (Frisco smelter)	.....	4,134,823	348,036	623
Horn silver mine (Horn Silver Mining company's smelter)	.....	5,660,298	347,313	10
Marsac company	.....	30,290	54,533	.....
Mingo Furnace company	.....	3,925,104	245,339	931
Morgan smelter	.....	2,673,200	257,568	1,480
Old Telegraph company	.....	6,128,927	153,735	92
Pascoe smelter	.....	14,348	5,700	24
Waterman smelter	.....	235,004	7,285	.....
Total	2,301,276	24,541,050	1,755,360	5,641
Lead, silver, and gold, in ores, shipped	.....	1,900,309	42,229	52
Total (ores and base bullion)	2,301,276	26,441,359	1,797,589	5,693
DORÉ BARS AND DUST.				
Germania smelting and refining works	.....	.....	24,680	240
Ontario Silver Mining company	.....	.....	1,165,180	.....
Stewart Mining company	.....	.....	.....	5,000
Other mills	.....	.....	6,043	3,000
Bingham placers	.....	.....	.....	1,000
Leeds district (Silver Reef)	.....	.....	841,555	.....
Total	.....	.....	2,037,458	10,230

TABLE CXXXVII.—WELLS, FARGO & CO.'S STATEMENT OF THE MINERAL PRODUCT, ETC.—Cont'd.

RECAPITULATION.

2,301,276 pounds refined lead, at 4½ cents per pound	$103,557 42
26,441,359 pounds unrefined lead, at $45 per ton (average price for 1879)	594,930 57
3,835,047 ounces silver, at $1 10 per ounce (average price for 1879)	4,218,551 70
15,032 ounces gold, at $19 per ounce (average price for 1879)	302,708 00
Total	5,219,747 69

Mr. Dooly states that the foregoing exhibit "includes the product of ores received from Idaho, Montana, and Nevada, aggregating 126,000 pounds lead, 102,800 ounces silver, and 200 ounces gold".

TABLE CXXXVIII.—WELLS, FARGO & CO.'S STATEMENT OF THE MINERAL PRODUCT OF UTAH FOR 1880.

Base bullion.	Lead, refined.	Lead, unrefined.	Silver.	Gold.
	Pounds.	*Pounds.*	*Ounces.*	*Ounces.*
Chicago smelter		2,990,861	127,382	357
Germania smelting and refining works	2,892,498	1,722,805	162,909	685
Horn silver mine (Frisco smelter)		2,017,991	125,722	350
Horn silver mine (Horn Silver Mining company's smelter)		6,646,357	463,552	
Mingo Furnace company		6,464,382	272,832	675
Morgan smelter		2,733,782	157,376	519
Old Telegraph company		4,243,668	119,401	150
Other smelters		152,234	4,841	44
Total	2,892,498	26,971,080	1,434,013	2,989
Deduct base bullion purchased for Germania refining works		1,980,587	54,218	134
Net product base bullion	2,892,498	23,610,493	1,379,795	2,855
Lead, silver, and gold, in ores, shipped		831,609	24,024	23
Total refined lead, ores, and base bullion	2,892,498	26,442,093	1,403,819	2,878
DORÉ BARS.				
Germania refining works			36,422	116
Ontario Silver Mining company			1,439,542	
Tintic Milling and Mining company			41,923	58
Other mills			15,798	4,118
Bingham placers				850
Silver Reef mills			846,062	
Total doré bars			2,379,747	5,142

RECAPITULATION.

2,892,498 pounds refined lead, at 5 cents per pound	$144,624 90
26,442,093 pounds unrefined lead, at $50 per ton (average price for 1880)	661,052 32
3,783,566 ounces silver, at $1 10 (average price for 1880)	4,161,922 60
8,020 ounces gold, at $20	160,400 00
Total export value	5,127,999 82

In explanation, the agent observes:

The above includes the product of ores received from Idaho, Montana, and Nevada, aggregating 784,450 pounds lead and 120,383 ounces silver. Computing the gold and silver at the mint valuation and lead at its value at the seaboard, it would increase the value of the product to $6,450,953 70.

ARIZONA.

A marked impulse has been given to the mining industry of Arizona by the fine showing of the new Tombstone district, in Pima county. The bullion production of this district had only begun in the period covered by the census year. A few months later, with increased milling facilities, a considerably higher rate of production was maintained.

The accompanying tables contain a probable error of at least 20 per cent., owing to the fact that no schedule data were available for estimating the production from the following sources: Various districts in Apache county; in Maricopa county, the Vulture mine (a large producer) and Myers district; in Mohave county, Aubrey, Hope, and San Francisco districts; in Pima county, Aztec, De Frees, Huachucha, Patagonia, Santa Catarina, and Tyndall districts, also several important mines in Tombstone district; in Pinal county, Mineral, Pinal, Randolph, and Summit districts, also the Silver King mine in Pioneer district and the Silver Era mine in Globe district; in Yavapai county, Agua Fria, Greenwood, Hassayampa, Lynx Creek, Martinez, Pine Grove, and Turkey Creek districts; in Yuma county, Bill Williams' Fork, Eureka, Harcuvar, La Paz, Montezuma, and Weaver districts. The estimates given for the production from the sources mentioned as not included in the schedule data furnished by the experts accordingly have a wide margin of uncertainty in comparison with the statements of the yield of localities from which fuller information was received.

TABLE CXXXIX.—ARIZONA—PRODUCTION OF DEEP

	County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	MARICOPA.													
1	Globe	1,989	1 51	114 43	115 94	145.1	2,999	176,039	227,601	230,600	264.00	.....	376 44	376 44
	Total	1,989	1 51	114 43	115 94	145.1	2,999	176,039	227,601	230,600	264.00	.....	376 44	376 44
	MOHAVE.													
1	Cedar Valley	80	.....	112 30	112 30	.....	.....	6,949	8,985	8,985	80.00	.....	92 88	92 88
2	Hualapai	2,188	12 91	80 15	93 06	1,367.1	28,260	135,664	175,400	203,660	463.00	19 98	157 38	157 36
3	Maynard	151	.....	144 00	144 00	.....	.....	16,818	21,744	21,744	151.00	.....	125 45	125 45
4	Owen's	160	.....	25 00	25 00	.....	.....	3,094	4,000	4,000	160.00	.....	*20 00	*20 00
5	Scattered	39	.....	271 97	271 97	.....	.....	8,204	10,607	10,607	39.00	.....	232 56	232 56
	Total	2,618	10 79	84 30	95 09	1,367.1	28,260	170,729	220,736	248,996	893.00	10 36	114 49	124 85
	PIMA.													
1	Arivaca	100	.....	*200 00	*200 00	.....	.....	*15,469	*20,000	*20,000	.....	.....	.....	.....
2	Dos Cabezas	370	31 32	1 32	32 64	560.7	11,591	379	490	12,081	.....	.....	.....	.....
3	Harshaw	4,650	.....	64 19	64 19	.....	.....	230,877	298,501	298,501	.....	.....	.....	.....
4	Hartford	50	.....	20 00	20 00	.....	.....	773	999	999	.....	.....	.....	.....
5	Oro Blanco	1,325	10 45	55 62	66 07	670.0	13,850	57,003	73,699	87,549	68.50	.....	*53 60	*53 60
6	Pima	310	.....	30 00	30 00	.....	.....	7,193	9,300	9,300	.....	.....	.....	.....
7	Swisshelm	410	.....	35 61	35 61	.....	.....	11,293	14,601	14,601	.....	.....	.....	.....
8	Tombstone	18,123	12 21	84 36	96 57	10,710.7	221,410	1,182,441	1,528,778	1,750,188	12,380.00	7 81	64 82	72 63
	Total	25,338	9 74	76 82	86 56	11,941.4	246,851	1,505,428	1,946,368	2,193,219	12,448.50	9 74	76 82	86 56
	PINAL.													
1	Globe	706	29 91	5 05	34 96	1,021.6	21,119	2,753	3,559	24,678	52.25	48 34	15 87	64 21
2	Pioneer	245	18 37	104 65	123 02	217.7	4,500	19,831	25,640	30,140	67.50	.....	59 26	59 26
3	Turquoise	250	.....	35 00	35 00	.....	.....	6,768	8,750	8,750	.....	.....	.....	.....
	Total	1,201	21 33	31 60	52 93	1,239.3	25,619	29,352	37,949	63,568	119.75	21 09	40 33	61 42
	YAVAPAI.													
1	Big Bug	1,500	.....	123 33	123 33	.....	.....	143,089	185,000	185,000	300.00	.....	*237 50	*237 50
2	Cave Creek	200	*25 00	.....	*25 00	*241.9	*5,001	.....	.....	*5,001	200.00	*20 00	.....	*20 00
3	Cherry Creek	500	*6 00	.....	*6 00	*145.1	*2,999	.....	.....	*2,999	200.00	*3 00	.....	*3 00
4	Humbug	1,850	.....	*200 00	*200 00	.....	.....	286,179	370,001	370,001	977.00	.....	243 45	243 45
5	Peck	325	.....	264 46	264 46	.....	.....	66,478	85,949	85,949	321.00	.....	202 36	202 36
6	Tiger	1,500	*2 00	*117 00	*119 00	*145.1	*2,999	*135,741	*175,500	*178,499	1,000.00	1 60	92 59	94 19
7	Walker	*25	*25 00	.....	*25 00	*30.2	*625	.....	.....	*625	*25.00	*20 00	.....	*20 00
8	Walnut Grove	300	*25 00	.....	*25 00	*362.8	*7,500	.....	.....	*7,500	.....	.....	.....	.....
9	Weaver No. 2	400	*25 00	.....	*25 00	*483.8	*10,001	.....	.....	*10,001	*200.00	*20 00	.....	*20 00
	Total	6,000	4 41	123 70	128 11	*1,408.9	*29,125	631,487	816,450	845,575	3,223.00	3 32	144 79	148 11
	YUMA.													
1	Castle Dome	1,100	.....	34 08	34 08	.....	.....	28,995	37,488	37,488	.....	.....	.....	.....
2	Ellsworth, Plumas, or Centennial	250	27 50	.....	27 50	332.6	6,875	.....	.....	6,875	204.00	5 00	.....	5 00
3	Myers	500	.....	50 00	50 00	.....	.....	19,337	25,001	25,001	.....	.....	.....	.....
4	Silver	80	.....	*75 00	*75 00	.....	.....	4,641	*6,000	*6,000	.....	.....	.....	.....
	Total	1,930	3 56	35 49	39 05	332.6	6,875	52,973	68,489	75,364	204.00	5 00	.....	5 00

*Estimated.

TABLE CXL.—ARIZONA—RECAPITULATION BY COUNTIES OF

	County.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
1	Maricopa	1,989.00	1 51	114 43	115 94	145.1	2,999	176,039	227,601	230,600	264.00	.....	376 44	376 44
2	Mohave	2,618.50	10 79	84 30	95 09	1,367.1	28,260	170,729	220,736	248,996	893.00	10 36	114 49	124 85
3	Pima	25,338.00	9 74	76 82	86 56	11,941.4	246,851	1,505,428	1,946,368	2,193,219	12,448.50	9 74	76 82	86 56
4	Pinal	1,201.00	21 33	31 60	52 93	1,239.3	25,619	29,352	37,949	63,568	119.75	21 09	40 33	61 42
5	Yavapai	6,000.00	4 41	123 70	128 11	*1,408.9	*29,125	631,487	816,450	845,575	3,223.00	3 32	144 79	148 11
6	Yuma	1,930.00	3 56	35 49	39 05	332.6	6,875	52,973	68,489	75,364	204.00	5 00	.....	5 00
	Total	39,676.50	8 56	83 61	92 17	16,434.4	339,729	2,566,008	3,317,593	3,657,322	17,152.25	7 01	86 24	93 25
	*Additional production	*8,576.00	*9 35	*114 99	*124 34	*2,877.9	*80,163	*762,745	*986,153	*1,066,316	*8,576.00	*7 01	*86 24	*93 25
	* Total production	*48,252.50	*8 70	*89 19	*97 89	*20,312.3	*419,892	*3,328,753	*4,303,746	*4,723,638	*25,728.25	*7 01	*86 24	*93 25

* Estimated.

MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Ozs.	Dolls.	Ozs.	Dollars.	Dolls.	
.....	.....	76, 866	99, 380	99, 380	1, 725. 00	145. 1	2, 999	82, 276	106, 375	109, 374	.....	.....	.....	.....	.....	1
.....	.....	76, 866	99, 380	99, 380	1, 725. 00	145. 1	2, 999	82, 276	106, 375	109, 374	.....	.....	.....	.....	.....	
.....	.....	5, 747	7, 430	7, 430	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
447. 5	9, 251	49, 195	63, 604	72, 855	1, 725. 50	709. 2	14, 660	85, 737	110, 849	125, 509	.....	.....	1, 183	1, 530	1, 530	2
.....	.....	14, 652	18, 944	18, 944	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
.....	.....	2, 475	*3, 200	*3, 200	.....	.....	.....	.....	.....	.....	.....	.....	9, 746	12, 600	a12, 600	4
.....	.....	7, 015	9, 070	9, 070	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
447. 5	9, 251	79, 084	102, 248	111, 499	1, 725. 50	709. 2	14, 660	85, 737	110, 849	125, 509	.....	.....	10, 929	14, 130	14, 130	
.....	.....	.....	.....	.....	100. 00	.....	.....	*15, 460	*20, 000	*20, 000	.....	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	370. 00	560. 7	11, 591	379	490	12, 081	.....	.....	.....	.....	.....	2
.....	.....	.....	.....	.....	4, 650. 00	.....	.....	230, 877	298, 500	298, 500	.....	.....	.....	.....	.....	3
.....	.....	.....	.....	.....	50. 00	.....	.....	773	1, 000	1, 000	.....	.....	.....	.....	(b)	4
.....	.....	2, 840	*3, 672	*3, 672	1, 256. 50	670. 0	13, 850	53, 453	69, 109	82, 959	.....	.....	.....	.....	.....	5
.....	.....	.....	.....	.....	310. 00	.....	.....	7, 193	9, 300	9, 300	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	410. 00	.....	.....	11, 293	14, 601	14, 601	.....	.....	.....	.....	.....	7
4, 680. 2	96, 748	620, 650	802, 450	899, 198	5, 743. 00	4, 617. 8	95, 458	443, 237	572, 661	668, 519	.....	.....	.....	.....	.....	8
4, 680. 2	96, 748	623, 490	806, 122	902, 870	12, 889. 50	5, 848. 5	120, 899	762, 674	986, 061	1, 106, 960	.....	.....	.....	.....	.....	
122. 2	2, 526	641	829	3, 355	653. 75	945. 8	19, 552	2, 366	3, 059	22, 611	.....	.....	.....	.....	.....	1
.....	.....	3, 094	4, 000	4, 000	177. 50	217. 7	4, 500	6, 153	7, 955	12, 455	.....	.....	.....	.....	.....	2
.....	.....	.....	.....	.....	250. 00	.....	.....	6, 768	8, 750	8, 750	.....	.....	.....	.....	.....	3
122. 2	2, 526	3, 735	4, 829	7, 355	1, 081. 25	1, 163. 5	24, 052	15, 287	19, 764	43, 816	.....	.....	.....	.....	.....	
.....	.....	*55, 109	*71, 250	*71, 250	1, 200. 00	.....	.....	85, 080	110, 000	110, 000	.....	.....	.....	.....	.....	1
193. 5	*4, 000	.....	.....	*4, 000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
*29. 0	*600	.....	.....	*600	300. 00	*87. 1	*1, 800	.....	.....	*1, 800	.....	.....	.....	.....	.....	3
.....	.....	183, 964	237, 847	237, 847	873. 00	.....	.....	79, 279	102, 500	102, 500	.....	.....	.....	.....	.....	4
.....	.....	50, 243	64, 959	64, 959	*4. 00	.....	.....	*919	*1, 188	*1, 188	.....	.....	.....	.....	.....	5
77. 4	1, 600	71, 617	92, 594	94, 194	500. 00	*48. 4	*1, 000	*45, 247	*58, 500	*59, 500	77. 4	1, 600	71, 617	92, 594	94, 194	6
24. 2	*500	.....	.....	*500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	300. 00	*362. 8	*7, 500	.....	.....	*7, 500	.....	.....	.....	.....	(c)	8
193. 5	*4, 000	.....	.....	*4, 000	200. 00	*241. 9	*5, 001	.....	.....	*5, 001	.....	.....	.....	.....	.....	9
517. 6	10, 700	360, 933	466, 650	477, 350	3, 377. 00	*740. 2	*15, 301	210, 525	272, 188	287, 489	77. 4	1, 600	71, 617	92, 594	94, 194	
.....	.....	.....	.....	.....	1, 100. 00	.....	.....	28, 995	37, 488	37, 488	.....	.....	.....	.....	.....	1
49. 3	1, 019	.....	.....	1, 019	46. 00	61. 2	1, 265	.....	.....	1, 265	.....	.....	.....	.....	.....	2
.....	.....	.....	.....	.....	500. 00	.....	.....	19, 337	25, 001	25, 001	.....	.....	.....	.....	.....	3
.....	.....	.....	.....	.....	80. 00	.....	.....	4, 641	*6, 000	*6, 000	.....	.....	.....	.....	.....	4
49. 3	1, 019	.....	.....	1, 019	1, 726. 00	61. 2	1, 265	52, 973	68, 489	69, 754	.....	.....	.....	.....	.....	

* Estimated. a From 2,340 tons tailings, yielding $5.38 per ton. b Copper 15 per cent. c Lead 65 per cent.; production quoted is for year ending December 31, 1880.

PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Ozs.	Dolls.	Ozs.	Dollars.	Dolls.	
.....	.....	76, 866	99, 380	99, 380	1, 725. 00	145. 1	2, 999	82, 276	106, 375	109, 374	.....	.....	.....	.....	.....	1
447. 5	9, 251	79, 084	102, 248	111, 499	1, 725. 50	709. 2	14, 660	85, 737	110, 849	125, 509	.....	.....	10, 929	14, 130	14, 130	2
4, 680. 2	96, 748	623, 499	806, 122	902, 870	12, 889. 50	5, 848. 5	120, 899	762, 674	986, 061	1, 106, 960	.....	.....	.....	.....	.....	3
122. 2	2, 526	3, 735	4, 829	7, 355	1, 081. 25	1, 163. 5	24, 052	15, 287	19, 764	43, 816	.....	.....	.....	.....	.....	4
517. 6	10, 700	360, 933	466, 650	477, 350	3, 377. 00	*740. 2	*15, 301	210, 525	272, 188	287, 489	77. 4	1, 600	71, 617	92, 594	94, 194	5
49. 3	1, 019	.....	.....	1, 019	1, 726. 00	61. 2	1, 265	52, 973	68, 489	69, 754	.....	.....	.....	.....	.....	6
5, 816. 8	120, 244	1, 144, 117	1, 479, 229	1, 599, 473	22, 524. 25	8, 667. 7	179, 176	1, 209, 472	1, 563, 736	1, 742, 902	77. 4	1, 600	82, 546	106, 724	108, 324	
*2, 908. 4	*60, 122	*572, 650	*739, 615	*799, 737	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
*8, 725. 2	*180, 366	*1, 716, 176	*2, 218, 844	*2, 399, 210	22, 524. 25	8, 667. 7	179, 176	1, 209, 472	1, 563, 736	1, 742, 902	77. 4	1, 600	82, 546	106, 724	108, 324	

TABLE CXLI.—ARIZONA—PRODUCTION OF PLACER MINES FOR THE YEAR ENDING MAY 31, 1880.

County and district.	Gold.	
	Ounces.	Dollars.
YAVAPAI COUNTY.		
Castle Creek	72.5	1,499
Hassayampa	193.5	4,000
Walker	241.9	5,000
Walnut Grove	48.4	1,001
Weaver No. 2	241.9	5,000
Total, as derived from schedule data	798.2	16,500
Additional production, estimated	*653.0	*13,499
Total production, estimated	*1,451.2	*29,999

*Estimated.

DISTRIBUTION.—In addition to the ordinary difficulties of the investigation, absolute refusals to furnish information were met with on the part of some of the important mining companies of Arizona. The following estimate of the actual distribution is probably a tolerable approximation:

Maricopa	$350,000
Mohave	200,000
Pima	1,000,000
Pinal	350,000
Yavapai	575,000
Yuma	2,000
Placer gold	30,000
Unknown sources	30,633
Total	2,537,633

IDAHO.

The tabulation of the output of this territory is based upon reports of the examining expert on 369 deep mines, 14 placer mines, 18 amalgamating mills, 2 arrastras, and 2 smelting works, besides several general reports on whole districts.

From 1876 up to the close of the census year, the product of this territory has been mainly dependent upon the older mining districts, of which the placer mines of Boisé basin have contributed a large proportion. The panic in the stock market of San Francisco in 1876 led to a suspension of operations in the principal Owyhee mines, which for some years previous to that period had yielded large returns. This crash was due quite as much to mismanagement of the mines themselves as to causes inherent in the speculative market; but whatever the reason, the result was the closing down of many mines which probably would have been still largely productive if properly worked. As the case now stands, the Owyhee district, which formerly yielded by far the greater part of the total output of the territory, at present furnishes only about one-fifth of the aggregate. It is to be hoped that at no distant time in the future this district may again appear as a large producing center.

Had the census statistics been collected only a few months later, the new and promising Wood river country would have added largely to the total product. Operations in this district were only seriously begun toward the close of May, 1880; hence the large product from ores shipped to Salt Lake during the fall of the same year does not enter into the tabulation for the census year.

In addition to the developments in the Wood river country, a number of other new localities appear as future important productive sources, prominent among which is the Sawtooth district, which from the absence of local milling facilities was at a standstill pending the erection of reduction works. Another year will witness a considerable bullion production from the mines of this district. The same remark holds good with regard to Smiley's cañon, from which a small amount of ore was shipped at great expense to distant points for reduction. The returns from these shipments were such as to give great hope for a large increase when it becomes possible to treat the ores at greater advantage in mills placed near the mines.

In the Yankee Fork region a decided impulse—the effect of which was not shown until the opening of the season of 1881—was given by the erection of the fine and well appointed mill of the Custer company. Previous to the building of this mill the ores of the district had either to be worked in arrastras, with a large percentage of loss, or be freighted at a heavy charge to Salt Lake, or elsewhere, for treatment. In spite of these disadvantages two mines were shipping considerable amounts of $900 ore, while a third was developing an immense body of ore which was expected to yield $300 per ton.

The smelting works recently constructed at Bay Horse and Kinnikinnick will also add largely to the total product.

The period covered by the census year, while one of great promise for the future of the territory, nevertheless showed a comparatively small yield. The probabilities are that within two years the output of Idaho will at least have doubled.

The deposits of Idaho bullion (so far as it is possible to segregate them—a very large portion having passed through private refineries and thus losing their identity) up to the close of the fiscal year ending June 30, 1880, are stated by the director of the mint to have been $24,137,417 gold, $727,296 silver, and $24,864,713 total. This amount is considerably within the actual output.

Of the total gold product of Idaho, 59.45 per cent. is from the placers, and 40.55 per cent. from the deep mines. Idaho furnishes 7.33 per cent. of the placer output of the United States, 2.81 per cent. of the deep-mine gold, and 4.43 per cent. of the total gold; 1.13 per cent. of the silver, and 2.61 per cent. of the entire product of the precious metals in the whole country. As a gold-producer the territory ranks sixth, and in silver, seventh. The average yield per square mile is $17 45 gold, $5 48 silver, and $22 93 total. In this respect Idaho stands fifth in point of gold, seventh in silver, and sixth in developed richness in gold and silver. The average yield per capita is $45 37 gold, $14 25 silver, and $59 62 in both precious metals, placing the rank as regards product in reference to population third as to gold, sixth as to silver, and fifth altogether. The comparison with regard to population is probably the most reliable test of the relative prosperity of a mining region.

TABLE CXLII.—IDAHO—PRODUCTION OF DEEP MINES

	County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	ALTURAS.													
1	Bear Creek, or Rocky Bar	429.00	49 53	.....	49 53	1,028.9	21,250	.....	.....	21,250	150.00	34 33	.....	34 33
2	Bonaparte	190.00	32 52	1 62	34 14	298.9	6,179	287	306	6,485	.....	.....	.....	.....
3	Buffalo, or Atlanta	2,288.75	37 56	60 30	97 66	4,136.4	85,507	106,761	138,031	223,538	558.00	61 92	106 51	168 43
4	Queen's River	300.00	56 83	3 33	60 16	824.8	17,050	773	1,000	18,050	.....	.....	.....	.....
5	Red Warrior	295.00	50 17	.....	50 17	715.9	14,799	.....	.....	14,799	200.00	42 69	.....	42 69
6	Sawtooth	*175.00	*10 00	*90 00	*100 00	84.7	*1,751	12,182	*15,750	*17,501	.....	.....	.....	.....
7	Smiley's Cañon	*200.00	*10 00	*65 00	*75 00	96.7	*1,999	10,055	*13,000	*14,999	.....	.....	.....	.....
8	(a) Wood River (b)	*200.00	.....	*100 00	*100 00	.....	.....	15,469	*20,000	*20,000	.....	.....	.....	.....
	Total	4,077.75	36 43	46 12	82 55	7,185.4	148,535	145,477	188,087	336,622	908.00	53 13	65 45	118 58
	BOISÉ.													
1	Banner	1,320.00	84	81 47	81 81	21.8	451	83,185	107,550	108,001	1,128.00	.....	74 63	74 63
2	Cañon Creek	355.00	91 19	.....	91 19	1,566.1	32,374	.....	.....	32,374	225.00	85 28	.....	85 28
3	Gambrinus	850.00	9 06	.....	9 06	372.5	7,700	.....	.....	7,700	600.00	5 50	.....	5 50
4	Granite, or Quartzburg	13,038.00	16 31	.....	16 31	10,288.6	212,643	.....	.....	212,643	12,800.00	13 28	.....	13 28
5	Mammoth, or Summit Flat	600.00	10 46	.....	10 46	303.6	6,276	.....	.....	6,276	550.00	9 50	.....	9 50
6	Shaw's Mountain	442.00	48 81	1 46	50 27	1,043.7	21,575	490	*645	22,220	342.00	36 59	83	37 42
	Total	16,605.00	16 92	6 51	23 43	13,594.3	281,019	83,684	108,195	389,214	15,645.00	13 44	5 39	18 83
	IDAHO.													
1	Copeland's, Deadwood, Florence, Mayfield's, Warren's Camp, Washington, scattered	*500.00	*25 00	.....	*25 00	604.7	*12,500	.....	.....	*12,500	*500.00	*20 00	.....	*20 00
	Total	*500.00	*25 00	.....	*25 00	604.7	*12,500	.....	.....	*12,500	*500.00	*20 00	.....	*20 00
	LEMHI.													
1	Bay Horse and Kinnickinnick, Clear Creek, Deep Creek, Dahlonega or Gibbonsville, Estes Mountain, Scarlet Mountain, Yankee Fork, Yellow Jacket, scattered	*5,000.00	*60 00	*60 00	*120 00	14,512.5	*300,000	232,036	*299,999	*599,999	*2,500.00	*50 00	*50 00	*100 00
	Total	*5,000.00	*60 00	*60 00	*120 00	14,512.5	*300,000	232,036	*299,999	*599,999	*2,500.00	*50 00	*50 00	*100 00
	NEZ PERCÉS.													
1	Moscow, scattered	*300.00	*20 00	.....	*20 00	290.3	*6,001	.....	.....	*6,001	*300.00	*15 00	.....	*15 00
	Total	*300.00	*20 00	.....	*20 00	290.3	*6,001	.....	.....	*6,001	*300.00	*15 00	.....	*15 00
	ONEIDA.													
1	Caribou, scattered	*500.00	*25 00	.....	*25 00	604.7	*12,500	.....	.....	*12,500	*500.00	*20 00	.....	*20 00
	Total	*500.00	*25 00	.....	*25 00	604.7	*12,500	.....	.....	*12,500	*500.00	*20 00	.....	*20 00
	OWYHEE.													
1	Carson, or Owyhee	7,247.75	33 00	33 44	66 44	11,605.8	239,913	188,538	243,761	483,674	6,625.75	25 39	25 77	51 16
2	Wagontown	995.00	23 88	37 27	61 15	1,270.5	26,264	28,752	34,588	60,852	451.00	20 90	8 44	29 34
3	Scattered	*100.00	*37 50	*37 50	*75 00	181.4	*3,750	2,900	*3,749	7,499	*100.00	*25 00	*25 00	*50 00
	Total	8,342.75	32 35	33 81	66 16	13,057.7	269,927	218,190	282,098	552,025	7,176.75	25 09	24 68	49 77
	WASHINGTON.													
1	Heath, scattered	*500.00	*15 00	.....	*15 00	362.8	*7,500	.....	.....	*7,500	*500.00	*10 00	.....	*10 00
	Total	*500.00	*15 00	.....	*15 00	362.8	*7,500	.....	.....	*7,500	*500.00	*10 00	.....	*10 00

a Lead, 60 per cent., or 120 tons.
b Big Smoky, Black Barb or Kelly's, Bradford or Jacob's City, Croy's Gulch, East Fork, Elk Mountain or Bullion, Galena, Greenhorn, Little Smoky, Lower Wood River, Mineral Hill, Star Mountain, Upper Wood River, Warm Springs.

* Estimated.

TABLE CXLIII.—IDAHO—RECAPITULATION BY COUNTIES OF

	County.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
1	Alturas	4,077.75	36 43	46 12	82 55	7,185.4	148,535	145,477	188,087	336,622	908.00	53 13	65 45	118 58
2	Boisé	16,605.00	16 92	6 51	23 43	13,594.3	281,019	83,684	108,195	389,214	15,645.00	13 44	5 39	18 83
3	Idaho	*500.00	*25 00	.....	*25 00	604.7	*12,500	.....	.....	*12,500	*500.00	*20 00	.....	*20 00
4	Lemhi	*5,000.00	*60 00	*60 00	*120 00	14,512.5	*300,000	232,036	*299,999	*599,999	*2,500.00	*50 00	*50 00	*100 00
5	Nez Percés	*300.00	*20 00	.....	*20 00	290.3	*6,001	.....	.....	*6,001	*300.00	*15 00	.....	*15 00
6	Oneida	*500.00	*25 00	.....	*25 00	604.7	*12,500	.....	.....	*12,500	*500.00	*20 00	.....	*20 00
7	Owyhee (a)	8,342.75	32 35	33 81	66 16	13,057.7	269,927	218,190	282,098	552,025	7,176.75	25 09	24 68	49 77
8	Washington	500.00	15 00	.....	15 00	362.8	7,500	.....	.....	7,500	500.00	10 00	.....	10 00
	Total	35,825.50	28 97	24 53	53 49	50,212.4	1,037,982	679,387	878,379	1,916,361	28,029.75	21 18	15 91	37 07

* Estimated. a Including 300 tons tailings reworked.

FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	
249.1	5,149	.....	.....	5,149	279.00	705.9	14,592	.....	.....	14,592	.....	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	190.00	298.9	6,179	237	306	6,485	.....	.....	.....	.....	.....	2
1,671.5	34,552	45,971	59,436	93,989	1,730.75	2,167.8	44,812	56,936	73,613	118,425	169.3	3,500	2,707	3,500	7,000	3
.....	.....	.....	.....	.....	300.00	824.7	17,048	773	1,000	18,048	.....	.....	.....	.....	.....	4
413.1	8,540	.....	.....	8,540	95.00	218.0	4,507	.....	.....	4,507	.....	.....	.....	.....	.....	5
.....	.....	.....	.....	.....	*175.00	84.7	*1,751	12,163	*15,751	*17,502	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	*200.00	96.7	*1,999	10,055	*13,000	*14,999	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	*200.00	.....	.....	15,489	*20,000	*20,000	.....	.....	.....	.....	.....	8
2,333.7	48,242	45,971	59,436	107,678	3,169.75	4,396.7	90,888	95,653	123,670	214,558	169.3	3,500	2,707	3,500	7,000	
.....	.....	65,111	84,182	84,182	192.00	21.6	451	12,388	17,309	17,760	.....	.....	.....	.....	.....	
928.3	19,189	.....	.....	19,189	130.00	567.9	10,499	.....	.....	10,499	166.2	3,436	.....	.....	3,436	1
159.6	3,299	.....	.....	3,299	*250.00	169.3	*3,500	.....	.....	*3,500	.....	.....	.....	.....	.....	2
8,223.7	169,999	.....	.....	169,999	238.00	998.7	20,645	.....	.....	20,645	.....	.....	.....	.....	.....	3
252.8	5,226	.....	.....	5,226	50.00	24.2	500	.....	.....	500	.....	.....	.....	.....	.....	4
605.5	12,517	219	283	12,800	*100.00	145.1	*2,999	.....	.....	*2,999	.....	.....	.....	.....	.....	5
10,169.9	210,230	65,330	84,465	294,695	960.00	1,867.0	38,594	13,388	17,309	55,903	166.2	3,436	.....	.....	3,436	6
483.7	*9,999	.....	.....	*9,999	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
483.7	*9,999	.....	.....	*9,999	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
6,046.9	*125,001	96,683	*125,001	*250,002	*2,500.00	7,256.2	*149,999	116,018	*150,000	*299,999	.....	.....	.....	.....	.....	
6,046.9	*125,001	96,683	*125,001	*250,002	*2,500.00	7,256.2	*149,999	116,018	*150,000	*299,999	.....	.....	.....	.....	.....	1
217.7	*4,500	.....	.....	*4,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
217.7	*4,500	.....	.....	*4,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
483.7	*9,999	.....	.....	*9,999	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
483.7	*9,999	.....	.....	*9,999	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
8,135.4	168,174	132,105	170,799	338,973	622.00	2,230.8	46,115	35,059	45,328	91,443	.....	.....	.....	.....	.....	
456.1	9,428	2,947	3,810	13,238	544.00	660.9	13,662	23,504	30,388	44,050	.....	.....	.....	.....	.....	1
120.9	*2,499	1,933	*2,499	*4,998	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
8,712.4	180,101	136,985	177,108	357,209	1,166.00	2,891.7	59,777	58,563	75,716	135,493	.....	.....	.....	.....	.....	3
241.9	*5,001	.....	.....	*5,001	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
241.9	*5,001	.....	.....	*5,001	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1

PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	
2,333.7	48,242	45,971	59,436	107,678	3,169.75	4,396.7	90,888	95,653	123,670	214,558	169.3	3,500	2,707	3,500	7,000	1
10,169.9	210,230	65,330	84,465	294,695	960.00	1,867.0	38,594	13,388	17,309	55,903	166.2	3,436	.....	.....	3,436	2
483.7	*9,999	.....	.....	*9,999	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
6,046.9	*125,001	96,683	*125,001	*250,002	*2,500.00	7,256.2	*149,999	116,018	*150,000	*299,999	.....	.....	.....	.....	.....	4
217.7	*4,500	.....	.....	*4,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
483.7	*9,999	.....	.....	9,999	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
8,712.4	180,101	136,985	177,108	357,209	1,166.00	2,891.7	59,777	58,563	75,716	135,493	.....	.....	.....	.....	.....	7
241.9	*5,001	.....	.....	*5,001	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
28,699.9	593,073	344,969	446,010	1,039,083	7,795.75	16,411.6	339,288	283,622	366,695	705,983	335.5	6,936	2,707	3,500	10,436	

TABLE CXLIV.—IDAHO—PRODUCTION OF HYDRAULIC, PLACER, DRIFT, AND RIVER MINES FOR THE YEAR ENDING MAY 31, 1880.

County and district.	Gold. Totals, by counties.	
	Ounces.	Dollars.
ADA.		
Various small placers	241.9	5,001
ALTURAS.		
Bane's Diggings, Bear Creek, California Bar, Elk Creek, Middle Boisé, Parsons' Bar, Red Warrior, Stanley Basin, Tuscarora Bar, scattered	1,693.1	34,999
BOISÉ.		
Bear Run, Boston, Bummer Hill, Centerville, Cold Spring Gulch, Elk Creek, Granite, Grayback Bar, Grimes' Creek, Larraway Creek, Last Chance Bar, Moore's Creek, Noble's Gulch, Pioneer, Placerville, Squaw Creek, Willow Creek, scattered	30,120.4	622,644
CASSIA.		
Bonanza Bar, Rock Creek, Salmon Falls, scattered	967.5	20,000
IDAHO.		
Butts' Bar, Copeland Diggings, Elk City, Florence, Gold Fork, Little Salmon River, Mallett's Placers, Meadow Creek, Miller Creek, Salmon River, Sand Creek, South Fork, Warren's, scattered	2,902.5	60,000
LEMHI.		
Anderson Creek, Curly Creek, Dahlonega or Gibbonsville, Jordan Creek, Salmon City, Yankee Fork, scattered	967.5	20,000
NEZ PERCÉS.		
Various small placers	483.8	10,001
ONEIDA.		
Eagle Rock, Iowa Bar, Snake River, Tin Cup, scattered	1,451.2	29,999
OWYHEE.		
Blue Gulch, Bruneau Valley, Jordan Creek, Meadow Creek, Ruby Gulch, scattered	2,515.5	52,000
SHOSHONE.		
Number One, scattered	483.8	10,001
WASHINGTON.		
Various small placers	725.6	14,999
Total	42,552.8	879,644

OREGON.

Oregon is one of the oldest of the western mining states, the discovery of gold within its limits having followed closely upon that in California. Its output has never been very large, in comparison with the yield of its neighbor state, but although the mines have become secondary to its agricultural resources in point of importance, they still furnish occupation and profit to many of its inhabitants. The quartz veins of Baker county, in the eastern portion of the state, adjoining Idaho territory, continue to yield the larger portion of the total deep-mine product of this state. The prevailing type of the Oregon ores is a free gold quartz, though rebellious gold ores, requiring special treatment, are found in some localities, and a small amount of silver is produced in Grant county.

The latter county takes the lead in surface mining, while Baker, Jackson, and Josephine counties are also productive of a considerable amount of placer gold.

Oregon now ranks seventh on the roll of the mining states in production of gold, eleventh in output of silver, and ninth in its yield of both metals. Its quota toward the total production of the United States is 7.71 per cent. of the placer gold, 0.80 per cent. of the deep-mine gold, 3.29 per cent. of the total gold, and only 0.07 per cent. of the total silver. The percentage of the total combined gold and silver product is 1.51 per cent. The average yield per square mile is $11 43 gold, $0 29 silver, and $11 72 total. The product per capita is $6 28 gold, $0 16 silver, and $6 44 total, giving Oregon a rank of seventh in gold, tenth in silver, and ninth in total bullion output, in point of production as relative to population. The small proportion per capita shows how completely mining has been overshadowed by other industries in this state.

TABLE CXLV.—OREGON—PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
BAKER.													
Burnt River	1,089	28 45	5 51	33 96	1,498.6	30,979	4,641	6,000	36,979	1,089	7 70	1 38	9 08
Chicken Creek	125	*45 94	.....	*45 94	*277.8	*5,743	.....	.....	*5,743	125	34 46	.....	34 46
Conner Creek	10,800	*5 00	.....	*5 00	*2,612.2	*53,999	.....	.....	*53,999	10,800	*4 70	.....	*4 70
Pocahontas	100	*258 75	.....	*258 75	*1,251.7	*25,875	.....	.....	*25,875	100	207 00	.....	207 00
Rye Valley	93	10 00	112 00	122 00	45.0	930	8,056	10,416	11,346	93	1 58	30 18	30 76
Silver Creek	130	30 00	30 00	60 00	188.7	3,901	2,016	3,899	7,800	.....	.....	.....	.....
Virtue	400	*46 66	.....	*46 66	*902.9	*18,664	.....	.....	*18,664	400	35 00	.....	35 00
Total	12,737	11 00	1 59	12 59	6,776.9	140,091	15,713	20,315	160,406	12,607	7 80	24	8 14
GRANT.													
Granite	1,200	76 87	45 88	122 75	4,462.1	92,240	42,579	55,051	147,291	1,015	67 21	13 43	80 64
Total	1,200	76 87	45 88	122 75	4,462.1	92,240	42,579	55,051	147,291	1,015	67 21	13 43	80 64
JOSEPHINE.													
Yank	150	*34 83	.....	*34 83	252.7	*5,224	.....	.....	*5,224	150	31 66	.....	31 66
Total	150	*34 83	.....	*34 83	*252.7	*5,224	.....	.....	*5,224	150	31 66	.....	31 66

County and district.	Bullion produced from ore raised and treated during census year.					Ore raised, but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
	Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Tons.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.
BAKER.																
Burnt River	405.9	8,390	1,160	1,500	9,890	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Chicken Creek	208.4	4,308	.....	.....	4,308	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Conner Creek	*2,455.5	*50,760	.....	.....	*50,760	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pocahontas	1,001.4	20,701	.....	.....	20,701	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rye Valley	7.1	147	2,171	2,807	2,954	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Silver Creek	.....	.....	.....	.....	.....	130	188.7	3,901	3,017	3,901	7,802	4.3	0 89	1,285	1,661	1,750
Virtue	677.2	13,999	.....	.....	13,999	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	4,755.5	98,305	3,331	4,307	102,612	130	188.7	3,901	3,017	3,901	7,802	4.3	89	1,285	1,661	1,750
GRANT.																
Granite	3,300.2	68,221	10,549	13,639	81,860	185	894.9	18,499	28,617	36,999	55,498	.....	.....	.....	.....	.....
Total	3,300.2	68,221	10,549	13,639	81,860	185	894.9	18,499	28,617	36,999	55,498	.....	.....	.....	.....	.....
JOSEPHINE.																
Yank	229.8	4,750	.....	.....	4,750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	229.8	4,750	.....	.....	4,750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

*Estimated.

TABLE CXLVI.—OREGON—RECAPITULATION BY COUNTIES OF PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

County.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
Baker	12,737	11 00	1 59	12 59	6,776.9	140,091	15,713	20,315	160,406	12,607	7 80	34	8 14
Grant	1,200	76 87	45 88	122 75	4,462.1	92,240	42,579	55,051	147,291	1,015	67 21	13 43	80 64
Josephine	150	*34 83	.....	*34 83	*252.7	*5,224	.....	.....	*5,224	150	31 66	.....	31 66
Total	14,087	16 86	5 35	22 21	11,491.7	237,555	58,292	75,366	312,921	13,772	12 44	1 30	13 74

County.	Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
	Gold.		Silver.		Total.		Gold		Silver.		Total.	Gold.		Silver.		Total.
	Ounces.	Dollars.	Ozs.	Dollars.	Dollars.	Tons.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.
Baker	4,755.5	98,305	3,301	4,307	102,612	130	188.7	3,901	3,017	3,901	7,802	4.3	6 89	1,285	1,661	1,750
Grant	3,300.2	68,221	10,549	13,639	81,860	185	894.9	18,499	28,617	36,999	55,498	.....	.....	.....	.....	.....
Josephine	229.8	4,750	.....	.....	4,750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	8,285.5	171,276	13,850	17,946	189,222	315	1,083.6	22,400	31,634	40,900	63,300	4.3	89	1,285	1,661	1,750

*Estimated.

TABLE CXLVII.—OREGON—PRODUCTION (GOLD) OF HYDRAULIC, PLACER, DRIFT, AND RIVER MINES FOR THE YEAR ENDING MAY 31, 1880.

County and district.	Gold.			
	Total by districts.		Total by counties.	
	Ounces.	Dollars.	Ounces.	Dollars.
BAKER.				
Amelia	290.2	5,999	7,262.8	150,136
Blue Cañon	333.8	6,900		
Chicken Creek	259.3	5,360		
Humboldt Basin	435.4	9,001		
Mormon Basin	130.6	2,700		
Pocahontas	1,803.2	37,317		
Rye Valley	1,112.6	22,999		
Shasta	747.4	15,450		
Sumter	1,632.6	33,749		
Willow Creek	515.7	10,660		
COOS.				
Black Hawk	3.6	74	3.6	74
CURRY.				
Sixes River	453.5	9,375	453.5	9,375
DOUGLAS.				
Big Bend, Cow Creek	177.6	3,671	620.5	12,827
Cañonville	237.7	4,914		
Green Mountain	205.2	4,242		
GRANT.				
Cañon City	6,482.3	134,001	14,096.5	291,401
Elk Creek	4,837.5	100,000		
Granite	353.1	7,299		
Marysville	774.0	16,000		
Prairie City	967.5	20,000		
Rock Creek	203.2	4,201		
Trail Creek	478.9	9,900		
JACKSON.				
Applegate	261.2	5,400		
Ashland	106.8	2,209		
Coyote Creek	322.9	6,675	9,132.7	188,790
Dry Diggings	145.1	3,000		
Farris Gulch	290.1	5,997		
Fort Lane	435.4	9,001		
Forty-Nine	285.9	5,910		
Grass Creek	290.3	6,001		
Jackass Creek	967.5	20,000		
Jacksonville	822.3	16,998		
Rogue River	483.8	10,001		
Sam's Valley	35.6	736		
Sardine Creek	1,161.0	24,000		
Sterling	1,511.3	31,241		
Uniontown	1,088.4	22,499		
Willow Springs	361.8	7,479		
Wolf Creek	563.3	11,644		
JOSEPHINE.				
Althouse	2,418.8	50,001	9,563.4	196,458
Cañon Creek	483.8	10,001		
Grass Creek	192.1	3,971		
Illinois	967.5	20,000		
Josephine	725.6	15,000		
Murphy	27.0	558		
Silver Creek	725.6	15,000		
Waldo	790.5	16,527		
Yank	3,163.5	65,395		
UMATILLA.				
Scattered	3,680.4	76,080	3,680.4	76,080
WASCO.				
Ochoco	58.1	1,201	58.1	1,201
	44,811.5	926,336	44,811.5	926,336

WASHINGTON.

Of the small product reported from the deep mines of Washington territory, nearly the whole comes from Peshaston district, in Yakima county, where gold quartz mining is conducted on a small scale.

The Upper Columbia placers furnish over one-half of the total placer yield of the territory. The Skagit mines, in Whatcom county, about which, from time to time, reports glittering with golden promise have been spread, are not yet to be numbered among the important productive deposits of the country. They have attracted much attention from the press, and have been the scene of several incipient "rushes", but the shortness of the season, inaccessibility, and other natural disadvantages have combined to retard operations, and the yield is still very scanty.

TABLE CXLVIII.—WASHINGTON—PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

County.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
	Tons.	Dolls.	Dolls.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
Yakima (Peshaston district)	437	*41 85	Trace.	*41 85	884.6	*18,288	.....	.....	*18,288	437	31 59	Trace.	31 59
Scattered	100	37 50	Trace.	37 50	181.4	3,750	.....	.....	3,750	100	30 00	Trace.	30 00
Total	537	41 04	Trace.	41 04	1,066.0	22,038	.....	.....	22,038	537	31 28	Trace.	31 28

County.	Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
	Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
	Ozs.	Dollars.	Ozs.	Dolls.	Dollars.	Tons.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.
Yakima (Peshaston district)	667.6	13,801	.....	.....	13,801	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Scattered	145.1	2,999	.....	.....	2,999	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	812.7	16,800	.....	.....	16,800	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

*Estimated.

TABLE CXLIX.—WASHINGTON—PRODUCTION (GOLD) OF HYDRAULIC, PLACER, DRIFT, AND RIVER MINES FOR THE YEAR ENDING MAY 31, 1880.

Locality.	Gold.	
	Ounces.	Dollars.
Whatcom county, Skagit mines	193.5	4,000
Yakima county, Swauk mines	483.7	9,999
Upper Columbia placers	2,902.5	60,000
All other placers	2,176.9	45,001
Total	5,756.6	119,000

ALASKA.

This vast territory, occupying an area of over half a million square miles, is for the most part still an unexplored region. The small amount of prospecting which has been done has developed the fact that Alaska contains many gold-bearing localities, none of which, however, have yet yielded any considerable output. The climate and remoteness from communications will always be obstacles in the way of mining, but in spite of the natural disadvantages of the country, it is reasonable to look for an increased product in the future. Recent reports, much exaggerated, of fabulous discoveries of mountains of silver ore have attracted many adventurous miners to Alaska. Thus far only disappointment has resulted. The small amount of placer gold received at the San Francisco mint from Alaska during the census year, $5,951, does not perhaps represent the whole product, as a portion may have found its way to Victoria, and thus have become identified with the product of British Columbia. No means of tracing this small possible balance are at hand. The total was in any event insignificant.

STATISTICS OF THE DIVISION OF THE ROCKY MOUNTAINS.

[Collected and compiled under the direction of Mr. S. F. Emmons, geologist-in-charge and special agent of census.]

COLORADO.

From an average production of only three or four millions, Colorado has suddenly risen to the first rank as a producer of the precious metals among the states and territories for gold and silver combined; as for silver alone it ranks first, while for gold it holds the fourth rank. In the relation of production to area, it holds the first rank, likewise, for gold and silver combined and for silver alone, and the third for gold alone. In the relation of production to population, however, it ranks only third for gold and silver together, second for silver alone, and sixth for gold alone. The total value of its product during the census year in gold and silver was, in round numbers, nineteen and a quarter million dollars, and if we add to this the value of lead and copper in crude metal produced, we have a total value of metallic product of twenty-two and three-quarters million dollars.

The collection of statistics of the precious metals in this state presents certain peculiar difficulties. First, from the fact that there are so many small mines which keep no accurate record of their production; second, because a very large proportion of its ores, being essentially heterogeneous in composition, have to be smelted, and are thus more difficult to trace than milling ores. The smelting ores are sold, it is true, mostly to smelters within the state, but the same mine often sells to different and widely separated works, and the smelters themselves buy ores in small lots from many mines, of which no separate record is kept. Moreover, the check furnished in the more western states over the total production by the express returns is here wanting, since, practically, the whole silver product is shipped east in lead bullion, of which the transportation companies keep no record. Nevertheless, owing to the almost uniform willingness which the more important mine-owners, samplers, and smelters have shown to afford the data which they possessed, it is believed that the totals attained represent a very close approximation to the actual product of the state, and that the figures given are, on the average, within 5 per cent. of the true amount, although in districts as yet incompletely developed this percentage may be greater.

As it was found impossible to separate with any degree of approximation the amount of "bullion produced", which should be credited to individual districts in several counties, the division into districts has been abandoned in such instances. In the following tables the amount and value of ore raised has been given to districts as far as was possible, the heading "Scattered" including, in general, mines from which no direct information was obtained, but which had sold ore to samplers or smelters. The sign of "estimated" (*) might be appended in many cases to amounts of bullion produced by counties, because these amounts were largely obtained by segregating returns of ore purchased by smelters, and apportioning to each county the corresponding proportion of bullion produced from that ore; thus, while the relative amounts may be considered estimates, the total footings of the columns are determined from comparatively accurate data.

TABLE CL.—COLORADO—STATEMENT OF ORE RAISED DURING THE YEAR ENDING MAY 31, 1880.

County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.				
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
BOULDER.									
Central, Gold Hill, Grand Island, Sugar Loaf, Ward	5,667.0	77 56	63 81	141 37	21,262.0	439,524	279,712	361,640	801,164
Scattered	2,201.0	8 22	12 52	20 74	875.0	18,088	21,313	27,555	45,643
Total	7,868.0	58 17	49 46	107 63	22,137.0	457,612	301,025	389,195	846,807
CHAFFEE.									
Chalk Creek, Free Gold, Monarch	944.0	17 91	170 24	188 15	818.0	16,910	124,296	160,702	177,612
Scattered	35.0	92 71	209 43	302 14	157.0	3,245	5,069	7,330	10,575
Total	979.0	20 58	171 64	192 22	975.0	20,155	129,365	168,032	188,187
CLEAR CREEK.									
Argentine, Banner, Cascade, Chicago, Geneva, Griffith, Idaho, Iowa, Montana, Morris, Queen, Seaton, Spanish Bar, Trail Run, Upper Union, Virginius	34,320.0	10 81	46 97	57 78	18,055.0	373,230	1,254,035	1,631,329	1,994,559
Scattered	2,511.0	1 12	133 70	134 82	136.0	2,811	257,729	333,218	336,029
Total	37,031.0	10 15	52 79	62 94	18,191.0	376,041	1,511,764	1,964,547	2,330,588

TABLE CL.—COLORADO—STATEMENT OF ORE RAISED, ETC.—Continued.

County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.				
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
CUSTER.									
Hardscrabble, Verde	15,802.0	04	36 49	36 53	30.0	620	446,046	576,693	577,313
Scattered	292.0	47 85	73 83	121 68	676.0	13,974	16,675	21,559	35,533
Total	16,094.0	91	37 17	38 06	706.0	14,594	462,721	598,252	612,846
GILPIN.									
Enterprise, Eureka, Gregory, Hawkeye, Nevada, Quartz Valley, Russell	110,745.0	14 86	4 35	19 21	79,590.0	1,645,271	372,956	482,195	2,127,466
Scattered	12,923.0	28 39	14 90	43 29	17,747.0	366,963	148,915	192,532	559,395
Total	123,668.0	16 27	5 46	21 73	97,337.0	2,012,134	521,871	674,727	2,686,861
GUNNISON.									
Ruby, Tin Cup	140.0	7 56	1,242 21	1,249 77	51.2	1,058	134,512	173,910	174,968
Scattered	112.0	71 62	69 55	141 17	388.0	8,021	6,025	7,790	15,811
Total	252.0	36 03	721 03	757 06	439.2	9,079	140,537	181,700	190,779
HINSDALE.									
Galena, Lake	2,371.0	3 49	65 10	68 59	400.0	8,269	119,390	154,359	162,628
Scattered	324.0	....	101 25	101 25	.....	.....	25,372	32,804	32,804
Total	2,695.0	3 07	69 45	72 52	400.0	8,269	144,762	187,163	195,432
HUERFANO.									
Third	35.0	20 69	96 97	117 66	35.0	724	2,625	3,394	4,118
Total	35.0	20 69	96 97	117 66	35.0	724	2,625	3,394	4,118
LAKE.									
California	152,241.0	23	90 05	90 28	1,716.0	35,473	10,603,331	13,709,047	13,744,520
Scattered	210.0	224 83	85 48	310 31	2,284.0	47,214	13,895	17,952	65,166
Total	152,451.0	54	90 04	90 58	4,000.0	82,687	10,617,216	13,726,999	13,809,686
LA PLATA.									
California	12.0	10 00	246 75	256 75	5.8	120	2,290	2,961	3,081
Total	12.0	10 00	246 75	256 75	5.8	120	2,290	2,961	3,081
OURAY.									
Iron Spring	428.5	118 16	312 45	430 61	2,449.2	50,629	103,555	133,886	184,515
Pioneer	100.0	22 95	144 94	167 89	111.0	2,295	11,210	14,493	16,788
Sneffles	94.5	1 05	377 75	378 80	4.8	99	27,612	35,700	35,799
Uncompahgre	820.0	11 73	33 47	45 20	465.5	9,623	21,226	27,442	37,065
Upper San Miguel	207.5	43 59	158 98	202 57	437.5	9,044	25,515	32,988	42,032
Scattered	139.5	17 41	239 65	251 06	117.5	2,429	25,210	32,594	35,023
Total	1,790.0	41 41	154 81	196 22	3,585.5	74,119	214,327	277,103	351,222
PARK.									
Buckskin	50.0	.....	181 00	181 00	.....	....	7,000	9,050	9,050
Horseshoe	1,500.0	.....	103 43	103 43	.....	.....	120,000	155,148	155,148
Montgomery	774.0	.....	158 02	158 02	.....	.....	94,598	122,366	122,366
Mosquito	818.0	7 22	139 45	146 67	285.7	5,906	88,230	114,073	119,979
Sacramento	395.0	.....	145 68	145 68	.....	.....	92,257	119,279	119,279
Scattered	1,327.0	76	144 72	145 48	67.0	1,385	204,500	264,398	265,783
Total	5,364.0	1 36	146 21	147 57	352.7	7,291	606,585	784,254	791,545
RIO GRANDE.									
Summit	550.0	15 50	.....	15 50	412.5	8,527	.....	....	8,527
Total	550.0	15 50	.....	15 50	412.5	8,527	.....	....	8,527
SAN JUAN.									
Animas	1,035.0	.....	116 43	116 43	.....	.....	93,205	120,505	120,505
Eureka	150.0	.....	139 98	139 98	.....	.....	16,240	20,997	20,997
Uncompahgre	1,350.0	.....	107 12	107 12	.....	.....	111,696	144,412	144,412
Scattered	190.0	10 50	236 16	246 66	96.5	1,995	34,706	44,871	46,866
Total	2,725.0	73	121 80	122 13	96.5	1,995	255,847	330,785	332,780
SUMMIT.									
Avalanche	600.0	10 33	.....	10 33	300.0	6,202	.....	....	6,202
Revere	75.0	103 36	19 39	122 75	375.0	7,752	1,125	1,454	9,206
Horn Silver	400.0	10 84	86 62	96 96	200.0	4,134	*26,800	34,650	38,784
Ten-Mile	3,200.0	.....	112 85	112 85	.....	.....	279,300	361,107	361,107
Scattered	571.0	.....	33 20	33 20	.....	.....	*14,884	18,959	18,959
Total	4,846.0	3 73	85 88	89 61	875.0	18,088	321,889	416,170	434,258

*Estimated.

TABLE CLI.—COLORADO—RECAPITULATION BY COUNTIES OF PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

County.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dollars.	Dollars.	Dollars.
Boulder	7,808	58 17	49 46	107 63	22,137.0	457,612	301,025	389,195	846,807	7,558.0	40 28	46 82	87 10
Chaffee	979	20 58	171 64	192 22	975.0	20,155	129,965	168,032	188,187	161.0	6 [illegible]	46 65	53 06
Clear Creek	37,031	10 15	52 79	62 94	18,191.0	376,041	1,511,754	1,954,547	2,330,588	a35,821.0	6 11	46 73	52 84
Custer	16,094	91	37 17	38 08	706.0	14,594	462,721	598,252	612,846	b6,784.0	2 12	10 66	12 78
Gilpin	123,668	16 27	5 46	21 73	97,337.0	2,012,134	521,871	674,727	2,686,861	123,645.0	13 08	2 61	15 69
Gunnison	232	36 03	721 03	757 06	439.2	9,079	140,537	181,700	190,779	252.0	18 11	100 00	118 11
Hinsdale	2,695	3 07	69 45	72 52	400.0	8,269	144,762	187,163	195,432	2,695.0	2 61	13 09	15 70
Huerfano	35	20 69	96 97	117 66	35.0	724	2,625	3,394	4,118	5.5	.....	57 27	57 27
Lake (c)	152,451	54	90 04	90 58	4,000.0	82,687	10,617,216	13,726,999	13,809,686	140,622.0	58	89 34	89 92
La Plata	12	10 00	246 75	256 75	5.8	120	2,290	2,961	3,081	12.0	8 58	226 00	234 58
Ouray	1,790	41 41	154 81	196 22	3,585.5	74,119	214,327	277,103	351,222	1,311.0	12 69	78 55	91 24
Park	5,364	1 36	146 21	147 57	352.7	7,291	606,585	784,254	791,545	5,364.0	18	95 67	95 85
Rio Grande	550	15 50	.....	15 50	412.5	8,527	.....	.....	8,527	550.0	9 79	.....	9 79
San Juan	2,725	73	121 39	122 12	96.5	1,995	255,847	330,785	332,780	1,352.0	1 29	104 31	105 60
Summit	4,846	3 73	85 88	89 61	875.0	18,088	321,889	416,170	434,258	4,446.0	1 16	79 66	80 82
Scattered	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	356,360	8 68	55 26	63 94	149,548.2	3,091,435	15,233,414	19,695,282	22,786,717	330,580.5	6 89	49 20	56 09

County.	Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
	Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ozs.	Dolls.	Ounces.	Dollars.	Dollars.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.
Boulder	14,728.3	304,461	273,688	353,851	658,312	310.0	1,423.0	29,416	21,470	27,759	57,175	.....	.....	9,487	12,268	12,268
Chaffee	*49.3	*1,019	*5,809	*7,510	*8,529	818.0	706.4	14,644	107,706	139,253	153,897	.....	.....	.....	.....	.....
Clear Creek	*10,562.3	*218,756	*1,294,774	*1,674,013	*1,892,769	1,210.0	2,053.5	42,450	133,254	172,284	214,734	.....	.....	.....	.....	.....
Custer	696.2	14,392	55,927	72,308	86,700	9,310.0	.....	.....	316,350	409,009	409,009	.....	.....	.....	.....	.....
Gilpin	*78,263.4	*1,617,848	*250,074	*323,321	*1,941,169	23.0	18.1	374	97	125	499	*11,425.7	236,190	*62,322	80,576	316,766
Gunnison	*220.3	*4,554	19,507	25,221	29,775	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hinsdale	277.8	5,743	99,958	129,236	134,979	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Huerfano	.....	.....	244	315	315	29.5	29.5	610	2,212	2,860	3,470	.....	.....	.....	.....	.....
Lake (c)	3,913.7	80,903	9,717,819	12,564,168	12,645,071	11,828.0	118.3	2,445	823,702	1,064,964	1,067,409	.....	.....	.....	.....	.....
La Plata	5.0	103	2,098	2,712	2,815	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ouray	*804.5	*16,630	*79,651	*102,981	*119,611	479.0	1,457.1	30,121	87,093	112,603	142,734	.....	.....	.....	.....	.....
Park	*46.0	*951	*396,921	*513,179	*514,130	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rio Grande	260.5	5,385	.....	.....	5,385	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
San Juan	*84.0	*1,736	*109,166	*141,141	*142,877	1,372.0	.....	.....	112,960	146,046	146,046	.....	.....	.....	.....	.....
Summit	*250.0	*5,168	*273,915	*354,145	*359,313	400.0	200.0	4,134	26,800	34,650	38,784	.....	.....	.....	.....	.....
Scattered	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,078.7	84,314	147,707	190,970	275,284
Total	110,181.3	2,277,649	12,579,551	16,264,101	18,541,750	25,779.5	6,007.9	124,194	1,631,644	2,109,553	2,233,747	15,504.4	320,504	219,516	283,812	604,316

* Estimated. a 14,384 tons lost by concentration. b 4,684 tons lost by concentration. c Including the Leadville district.

In the foregoing tables the following are the more important items of uncertainty or inadequacy of data:

Arapahoe county.—In this county as well as in Jefferson and Pueblo counties no mines producing gold and silver are known to exist. In these, however, are located important smelting works, which buy and treat ores from almost every county in the state, as well as from Montana and New Mexico. The bullion production of these counties would therefore be an important fraction of the total bullion yield of the state. It has, however, been considered best to apportion this yield as nearly as possible among the districts or counties in which the ore was raised. This has been done in the following manner: The greater part of the ore treated could be traced back to the county where it was raised, and the total bullion product of each such lot was deduced from the average assay value of such lot, of the total amount treated, and of the total amount of bullion produced, in the case of each individual smelter. A portion of ore treated and bullion produced therefrom, which could not be directly traced back to its source, was distributed on estimated proportions, founded mainly on the relative amounts of ore produced, as determined by schedules and previous estimates. In considering the amount of bullion produced and ore treated, there is this element of uncertainty in some of our calculations, that the larger smelters cannot always say that the

bullion produced was from the very lots of ore purchased, as they keep a varying stock of ore on hand. It is probable, however, that, considering the whole, the figures obtained are sufficiently near the truth.

Boulder county.—No reliable data could be obtained in regard to the Niwot mine, which is said to produce about 15,000 tons of ore per year. In general the returns from this county were more incomplete and less satisfactory than from most counties in the state. It was not possible to apportion out by districts even the ore raised. The product, as obtained from smelters, is approximately correct, that from mills less certain and probably incomplete.

Chaffee county contains a number of promising mines, but owing to absence of owners no reliable data of production during census year could be obtained.

Clear Creek county includes a great number of small districts, within a limited region, whose boundaries are not always clearly defined; hence no allotment of ore by districts was attempted. One element of uncertainty in this district is the very common practice of leasing the mine to one or more parties, who pay the owner a royalty, or a portion of the gross product. A second is, that the ores are sampled, frequently concentrated, and sometimes treated in Gilpin county. Small lots of rich ore have been also shipped to smelters in the east, of which no record could be obtained. The loss by concentration (14,384 tons) was obtained by actual returns from ore-dressing works in one case only, of a few hundred tons, an estimate being made of the degree of concentration. The proportionately large loss in treatment is due, doubtless, to defective systems of working, but may be less than shown by the figures given above, since the product of rich ores shipped east does not appear here.

Custer county.—Its production is relatively low, since the Bassick mine did not produce during a great part of the census year. The loss by concentration (4,684 tons) is an estimate, deducting the sum of tons treated and tons remaining on hand from tons raised.

Gilpin county.—Owing to the system pursued by a large proportion of the mines and mills, viz: that the miners send their ore to custom mills to be treated, and receive in return the bullion produced, less charges, without any assay control, to determine how much was lost in treatment, or any record being kept by mills of value of bullion returned, it has been necessary to estimate a large proportion of the bullion thus produced. The express returns give for the year ending June 30, 1880, a shipment from Central City of 88,016 ounces gold bullion, of reported value of $1,320,260. The census figures for the year ending May 31, 1880, are somewhat less, viz: For the mill production, 54,361.8 ounces fine gold, having a mint value of $1,123,758 11, showing that this estimate is probably somewhat under the truth, although it is not certain that absolutely all bullion shipped from Central City was produced within Gilpin county. The figures in the column of "Bullion from ore raised prior to census year" are an estimate of the yield of tailings from the mills, which were sold to smelters during the year, and which are supposed to come mainly from ore raised during previous years.

Gunnison county.—But few mines were sufficiently developed to be regular producers during the census year, and many small lots shipped out for treatment may have escaped the record.

Hinsdale county.—The principal smelting works of the San Juan region are located here, and its production includes probably some small lots of ore raised in Ouray and San Juan counties, which could not be segregated.

Huerfano county has but few mines. From only a single district were returns made by the expert who had charge of this portion of the state.

Lake county.—Is the largest producer and furnishes the most accurate data, though it has been impossible in every case to actually trace back the bullion produced to the individual mine from which it came. The figures given are known to be under the truth for the following reason: The "American" and "Gage, Hagaman & Co.'s" smelters ran during a portion of the year, but were shut down and changed hands, so that when these statistics were collected no record, or even estimate, could be obtained of the amount of bullion produced by them. A thousand tons of crude bullion, of an average of 300 ounces silver per ton, would probably be an outside figure for the production of the two. This would add 300,000 ounces silver to the total production for the year. No record was obtained of the amount of ore, if any, which was shipped directly from Leadville to the smelting works at Omaha; its influence on the total production would be, at all events, inconsiderable. With these exceptions the figures given present a very accurate estimate of the bullion produced. With regard to the gold production the amount contained in the ores is in general too small to be taken account of, and it is only when concentrated in the lead bullion that it becomes appreciable; moreover a considerable portion of it comes from small lots of auriferous ores purchased by smelters from mines or prospects in outlying districts within the county, and in some cases from Gunnison or Summit counties. The gold contents of ore raised had therefore to be largely determined by estimate.

La Plata county.—From this county reports of only a single district were obtained, as the mines were as yet but little developed in the census year; probably many small lots of ore are unaccounted for.

Ouray county.—Doubtless from this county also the returns are somewhat incomplete, and it is certain that some addition is due to the amount of "bullion produced" which has been credited to it. Unfortunately data are wanting for making an accurate estimate, although it is known that some of this has been credited to Hinsdale county.

Park county.—At the time of collecting these statistics accurate data could be obtained from but few of the producing mines of this county; it has been necessary, therefore, to deduce them largely from information obtained from samplers and smelters, and estimate their proportionate bullion yield.

Rio Grande county.—Here, also, returns were obtained from but a single district.

San Juan county.—To this the same remarks are applicable which were made in regard to Ouray county.

Summit county.—From this county, for various reasons, the returns as regards the census year are rather incomplete, and figures probably below the truth. The bullion produced also had to be largely estimated. The following years will probably show an increased production.

To show the data from which the figures given above have been obtained the number of mines from which full schedules were received is subjoined, and the proportion thereof that have been bullion-producers during the census year, as well as those producers of which data have been obtained otherwise than by schedules and visits of census experts:

Total deep mines scheduled	249
Productive mines scheduled	126
Productive mines reported otherwise	249
Total productive mines reported	375
Total all mines reported on	498

TABLE CLII.—COLORADO—PRODUCTION OF PLACER MINES FOR THE YEAR ENDING MAY 31, 1880.

County.	Gold.	
	Ounces.	Dollars.
Chaffee	1,275.0	26,357
Clear Creek	410.0	8,475
Lake	835.0	17,261
Park	1,000.0	20,672
Routt	241.9	5,001
Summit	1,160.0	23,979
Total	4,921.9	101,745

The above table gives all the data which were obtained by the experts engaged in this work on placer and hydraulic workings in the state. The inherent difficulty of obtaining complete information with regard to surface mining, in that it is carried on only during a limited portion of the year, and in great part by individuals who keep no accurate account of their gains, renders these returns necessarily incomplete here as elsewhere. In Colorado, moreover, owing to the fact that other gold bullion is produced so largely, it has been impossible to supplement these figures by express or mint returns. While the above figures doubtless very inadequately express the production of placer gold for the state, it is a fact that this production was relatively small during the census year, owing to the unusual activity in prospecting for and working deep mines.

COPPER AND LEAD PRODUCTION IN COLORADO.

Although copper and lead belong rather to the useful than to the precious metals, their importance among the mineral products of Colorado, and their intimate connection with the production of gold and silver, render their consideration here essential. In Table CLIII, given below, only the crude metal obtained from ores actually smelted within the state is given, no account being taken of the copper or lead contained in ores which were shipped outside of the state for treatment. This amount is, however, of comparatively little importance, forming probably not over 5 per cent. of the total product. The lead product was all in the form of argentiferous lead bullion, which was shipped to various smelters in the East to be refined.

The copper product was partly as matte, but largely in the form of copper oxide. Of the actual shipments of the latter a portion has been produced from ores raised in Montana; a proportionate amount of the total product has, however, been credited to that territory in its appropriate place.

In calculating the value of these metals the average market value of either for the year has been assumed as 4½ cents per pound for lead, 20 cents per pound for copper.

TABLE CLIII.—COLORADO—CRUDE BULLION PRODUCT FOR THE YEAR ENDING MAY 31, 1880.

County.	Gross tons.	Lead.		Copper.		Gold.		Silver.		Total.
		Tons.	Dollars.	Tons.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
Arapahoe	1,225			980	392,000					392,000
Hinsdale	800	790.00	71,100			270.0	5,581	96,878	125,254	201,935
Jefferson	1,117	525.75	47,318	598	239,200	10,315.0	213,231	565,020	730,514	1,230,263
Lake	28,383	28,226.00	2,540,340			3,890.2	79,177	8,053,946	10,412,947	13,032,464
Ouray	90	89.00	8,010					24,103	31,163	39,173
Park	57	56.00	5,040					11,906	15,510	20,550
Pueblo	2,191	2,126.50	191,385			1,347.0	27,845	1,557,608	2,013,831	2,233,061
Summit	260	256.00	23,040					10,400	13,446	36,486
Total	34,123	32,069.25	2,886,233	1,578	631,200	15,762.2	325,834	10,319,951	13,342,665	17,185,932

Lead, $90 per ton. Copper, $400 per ton.

In the subjoined table are shown the relative amounts of ore treated by mill process and by smelting, and their average yield per ton. Its principal value is to show the average character of ore in each county in reference to its adaptation to either process of reduction. It would have been extremely interesting, had the data been such as would yield accurate results, to have given the assay value of the ore treated in either case, and thus compare the relative losses in either process, but the number of cases in which it has been necessary to estimate product from assay value, or *vice versâ*, would seriously impair the value of such comparison. This subject will be found treated at length in another part of the report.

TABLE CLIV.—COLORADO—PRODUCTION OF SMELTING WORKS AND AMALGAMATING MILLS FOR THE YEAR ENDING MAY 31, 1880.

County.	Ores raised and smelted.	Average yield per ton.			Bullion produced from ore smelted during census year.				
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
Boulder	3,412.0	68 52	47 10	115 62	11,309.8	233,794	124,307	160,717	394,511
Chaffee	161.0	*6 33	*46 65	*52 98	*49.3	*1,019	*5,809	*7,510	*8,529
Clear Creek (a)	9,701.0	11 93	116.26	128 19	*5,599.3	*115,748	*872,344	*1,127,854	*1,243,602
Custer (b)	982.0	14 24	64 65	78 89	676.2	13,978	49,107	63,490	77,468
Gilpin	10,218.0	48 36	28 26	76 62	23,901.5	494,088	223,305	288,711	782,799
Gunnison	252.0	18 11	100 00	118 11	*220.3	*4,554	19,507	25,221	29,775
Hinsdale	2,695.0	2 61	13 09	15 70	277.8	5,743	99,958	129,236	134,979
Huerfano	5.5	.....	57 27	57 27	.....	.....	244	315	315
Lake	140,623.0	58	89 34	89 92	3,913.7	80,903	9,717,819	12,564,168	12,645,071
La Plata	12.0	8 58	226 00	234 58	5.0	103	2,098	2,713	2,816
Ouray	1,015.0	6 66	100 62	107 28	327.0	6,760	78,995	102,133	108,893
Park	5,364.0	*18	*95 67	*95 85	*46.0	*951	*396,921	*513,179	*514,130
Rio Grande	.....	.....	.....	.....	.....	.....	.....	.....	.....
San Juan	1,353.0	*1 29	*104 31	*105 60	*84.0	*1,736	*109,166	*141,141	*142,877
Summit	3,771.0	.....	*93 91	*93 91	.....	.....	*273,915	*354,145	*354,145
Total	179,564.5	5 34	86 21	91 55	46,409.9	959,377	11,973,495	15,480,533	16,439,910

County.	Ores raised and milled.	Average yield per ton.			Bullion produced from ore milled during census year.				
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
Boulder	4,146	17 05	46 58	63 63	3,418.5	70,667	149,381	193,135	263,802
Chaffee	.....	.....	.....	.....	.....	.....	.....	.....	.....
Clear Creek (a)	11,736	8 78	46 54	55 32	*4,983.0	*103,008	*422,430	*546,160	*649,168
Custer (b)	1,118	.38	7 88	8 26	20.0	413	6,820	8,818	9,231
Gilpin	118,427	9 91	30	10 21	54,361.9	1,123,760	26,769	34,610	1,158,370
Gunnison	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hinsdale	.....	.....	.....	.....	.....	.....	.....	.....	.....
Huerfano	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lake	.....	.....	.....	.....	.....	.....	.....	.....	.....
La Plata	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ouray	.....	.....	.....	.....	.....	.....	.....	.....	.....
Park	296	33 35	2 86	36 21	477.5	9,871	656	848	10,719
Rio Grande	.....	.....	.....	.....	.....	.....	.....	.....	.....
San Juan	550	9 79	.....	9 79	260.5	5,385	.....	.....	5,385
Summit	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	675	*7 66	.....	*7 66	*250.0	*5,168	.....	.....	*5,168
	131,948	9 99	5 94	15 93	63,771.4	1,318,272	606,056	783,571	2,101,843

* Estimated.

a 14,384 tons lost by concentration.

b 4,094 tons lost by concentration.

DAKOTA.

The metallic production of Dakota is derived from the region of the Black Hills, and in greater part from Lawrence county, where free-milling gold-quartz ores of low grade are reduced in amalgamating mills of great size. The perfection to which the milling process has been brought is shown by the large percentage of the assay value extracted. Custer and Pennington counties are opening new mines, but had scarcely become producers during the census year.

The following table gives the production of deep mines, by districts, for the Black Hills region:

TABLE CLV.—DAKOTA—PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dollars.	Dollars.	Dollars.
CUSTER.													
Cole	300	21 33	0 02	21 35	309.6	6,400	3	4	6,404				
Custer	1,950	12 74	08	12 82	1,202.1	24,850	119	154	25,004				
Total	2,250	13 89	07	13 96	1,511.7	31,250	122	158	31,408				
LAWRENCE.													
Bear Butte	4,420	3 56	13 03	16 59	761.9	15,750	44,534	57,578	73,328	1,905	41	15 34	15 75
Lost Placer	78,060	8 00	11	8 11	30,209.2	624,480	6,381	8,250	632,730	71,060	7 53	08	7 61
Whitewood	444,518	7 63	25	7 88	164,092.2	3,392,086	85,275	110,252	3,502,338	422,665	6 16	08	6 24
Total	526,998	7 65	34	7 99	195,063.3	4,032,316	136,190	176,080	4,208,396	495,630	6 33	15	6 48
PENNINGTON.													
Cross	250	57 00	2 00	59 00	693.3	14,249	387	500	14,749				
Newton Forks	850	9 27	24	9 51	381.2	7,880	154	199	8,079				
Rockford	6,400	8 62		8 62	2,668.4	55,161			55,161	500	3 20		3 20
Total	7,500	10 31	09	10 40	3,738.9	77,290	541	699	77,989	500	3 20		3 20

County and district.	Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
	Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
	Ounces.	Dollars.	Ozs.	Dolls.	Dollars.	Tons.	Ounces.	Dolls.	Ozs.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.
CUSTER.																
Cole						300	309.6	6,400	3	4	6,404					
Custer						1,950	1,202.1	24,850	119	154	25,004					
Total						2,250	1,511.7	31,250	122	158	31,408					
LAWRENCE.																
Bear Butte	37.5	775	22,614	29,238	30,013	2,515	577.8	11,944	15,731	20,339	32,283					
Lost Placer	25,882.8	535,045	4,621	5,974	541,019	7,000	2,708.9	55,998	580	750	56,748					
Whitewood	125,839.4	2,601,331	27,342	35,351	2,636,682	21,853	9,335.0	192,972	8,430	10,899	203,871	5,622.7	116,233			116,233
Total	151,759.7	3,137,151	54,577	70,563	3,207,714	31,368	12,621.7	260,914	24,741	31,988	292,902	5,622.7	116,233			116,233
PENNINGTON.																
Cross						250	693.3	14,249	387	500	14,749					
Newton Forks						850	381.2	7,880	154	199	8,079					
Rockford	77.4	1,600			1,600	5,900	2,549.4	52,701			52,701					
Total	77.4	1,600			1,600	7,000	3,619.9	74,830	541	699	75,529					

The following table is a condensation of the preceding, and gives the deep-mine production by counties only:

TABLE CLVI.—DAKOTA—RECAPITULATION BY COUNTIES OF PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

County.	Ore raised during census year.	Average assay value per ton.			Assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dollars.	Dollars.	Dollars.
Custer	2,250	13 89	0 07	13 96	1,511.7	31,250	122	158	31,408				
Lawrence	526,998	7 65	34	7 99	195,063.3	4,032,316	136,100	176,080	4,208,396	495,630	6 23	0 15	6 48
Pennington	7,500	10 31	09	10 40	3,738.9	77,290	541	699	77,989	500	3 20		3 20
Total	536,748	7 71	33	8 04	200,313.9	4,140,856	136,853	176,937	4,317,793	496,130	6 33	14	6 47

County.	Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
	Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
	Ounces.	Dollars.	Ozs.	Dolls.	Dollars.	Tons.	Ounces.	Dolls.	Ozs.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.
Custer						2,250	1,511.7	31,250	122	158	31,408					
Lawrence	151,759.7	3,127,151	54,577	70,563	3,207,714	31,368	12,621.7	260,914	24,741	31,968	292,902	5,622.7	116,233			116,233
Pennington	77.4	1,600			1,600	7,000	3,619.9	74,830	541	699	75,529					
Total	151,837.1	3,128,751	54,577	70,563	3,209,314	40,618	17,753.3	366,994	25,404	32,845	399,839	5,622.7	116,233			116,233

PLACER AND HYDRAULIC MINES.

The following table gives the production of hydraulic and placer mines so far as could be ascertained by the expert in charge of this district. The amount seems very small, compared with the supposed value of the surface deposits in this region. This may be in part accounted for by the fact that several important companies were making ditches, and preparing for work on a large scale, but had not become producers during the census year.

TABLE CLVII.—DAKOTA—PRODUCTION OF HYDRAULIC, PLACER, DRIFT, AND RIVER MINES FOR THE YEAR ENDING MAY 31, 1880.

		Ounces.	Dollars.
Lawrence county	Gold	2,307.5	47,700
Pennington county	do	152.8	3,159
Total		2,460.3	50,859

MONTANA.

Montana has within its boundaries the elements favorable to a large production of the precious metals—rich and varied ores and abundant fuel, both coal and wood. As yet, however, owing to lack of development and want of sufficient transportation facilities, it has not taken its proper rank as a producer. Owing to the great extent of territory over which its mines are scattered, and the fact that, from circumstances beyond our control, the collection of statistics was not completed until the winter was far advanced, and travel rendered thereby very difficult, our data leave something to desire in point of completeness. It was evident that the figures of gold production deduced from the schedules were below the truth, since the mint returns report the gold production of Montana as a little over a million dollars in excess. As the mint figures are certainly below the truth, it was proper that this difference should be added, the only question being to what branch of mining it should be credited. Now, the census returns from placer and hydraulic mines were notoriously incomplete, since, owing to the lateness of the season, but few of their owners could be found; but it is well known that they form the most important element in the gold production of Montana. On the other hand, it was thought that returns had been obtained from practically all the mills and smelting works. Under these circumstances it was judged best to discard the census figures for hydraulic and placer mines altogether, and assume as their production the difference between the amount of gold produced, as determined by mill and smelters' returns, and the total product obtained from mint returns. While, therefore, it is possible that a small amount of the gold credited to hydraulic and placer mines may belong to mill production, it is probably not more than that by which the mint returns fall short of giving the total gold production of the territory as gold which, for various reasons, has not passed through the hands of its agents.

The following table gives the production of the deep mines of Montana by districts, and the yield of the ore treated, as far as could be ascertained, though some small lots of ore are known to have been shipped east, which could not be traced:

TABLE CLVIII.—MONTANA—PRODUCTION OF DEEP

	County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	BEAVER HEAD.													
1	Bald Mountain	300	.....	53 87	53 87	.....	.....	12,501	16,163	16,163	300.0	.....	26 87	26 87
2	Bannock	1,190	20 43	34	20 77	1,176.2	24,314	300	399	24,713	1,190.0	16 59	25	16 84
3	Trapper	9,446	.....	109 62	109 62	.....	.....	800,917	1,035,506	1,035,506	9,412.0	.....	76 61	76 67
	Total	10,936	2 22	96 19	98 41	1,176.2	24,314	813,727	1,052,068	1,076,382	10,902.0	1 81	66 90	68 71
	DEER LODGE.													
1	Flint Creek	5,315	.....	81 45	81 45	.....	.....	334,880	432,902	432,902	5,748.0	.....	82 63	82 63
2	Independence	4,100	1 17	69 69	70 86	232.2	4,800	221,000	285,731	290,531	888.0	.....	71 60	71 60
3	Silver Creek	19,000	13 00	47	13 47	11,948.6	247,000	6,884	8,900	255,900	14,000.0	12 00	50	12 50
4	Summit Valley	52,841	4 98	55 72	60 70	12,729.9	263,150	2,277,484	2,944,559	3,207,709	38,393.0	4 42	44 75	49 17
	Total	81,256	6 34	45 19	51 53	24,910.7	514,950	2,840,198	3,672,092	4,187,042	57,029.0	5 92	34 83	40 75
	JEFFERSON.													
1	Cataract	500	192 00	6 98	198 98	4,644.0	96,000	2,700	3,491	99,491	203.0	26 06	.....	26 06
2	Cedar Plain	800	32 00	4 00	36 00	1,238.4	25,600	2,475	3,200	28,800	800.0	16 00	2 00	18 00
3	Colorado	540	41 34	83 80	125 14	1,080.0	22,326	35,060	45,252	67,578	540.0	12 28	70 17	82 45
4	Elkhorn	600	.....	77 57	77 57	.....	.....	36,000	46,544	46,544	600.0	.....	58 18	58 18
5	Mountain	325	90 00	.....	90 00	1,415.0	29,251	.....	.....	29,251	325.0	70 00	.....	70 00
6	Scattered	570	16 00	1 00	17 00	441.2	9,120	441	570	9,690	570.0	15 26	28	15 54
	Total	3,335	54 66	29 70	84 36	8,818.6	182,297	76,616	99,057	281,354	3,038.0	18 49	24 54	43 03
	LEWIS AND CLARKE.													
1	Silver Creek, or Ottawa	7,150	16 40	5 17	21 57	5,672.4	117,259	28,600	36,977	154,236	7,000.0	13 14	1 15	14 29
2	Stemple	2,843	14 62	10 31	24 93	*2,010.5	*41,561	*22,682	*29,326	*70,887	2,843.0	11 39	6 05	17 44
3	Owyhee	500	22 00	25	22 25	532.1	10,999	97	125	11,124	500.0	14 30	.....	14 30
	Total	10,493	16 18	6 33	22 51	8,215.0	169,819	51,379	66,428	236,247	10,343.0	12 71	2 44	15 15
	MADISON.													
1	Hot Springs	929	81 75	12 58	94 33	3,673.8	75,944	9,040	11,688	*87,632	880.5	39 52	09	39 61
2	Mineral Hill	155	192 89	4 52	197 41	*1,446.3	*29,896	542	701	*30,599	130.0	90 00	2 29	92 29
3	Red Bluff	4	24 00	.....	24 00	*4.7	*97	.....	.....	*97	4.0	18 00	.....	18 00
4	Silver Star	7,750	18 78	.....	18 78	*7,041.4	*145,559	.....	.....	*145,559	4,250.0	9 47	.....	9 47
	Total	8,838	28 45	1 40	29 85	*12,166.2	*251,496	9,582	12,389	*263,887	5,264.5	16 49	07	16 56

* Estimated.

TABLE CLIX.—MONTANA—RECAPITULATION BY COUNTIES OF

	County.	Ore raised during census year.	Average assay value per ton.			Assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
1	Beaver Head	10,936	2 22	96 19	98 41	1,176.2	24,314	813,727	1,052,068	1,076,382	10,902.0	1 81	66 90	68 71
2	Deer Lodge	81,256	6 34	45 19	51 53	24,910.7	514,950	2,840,198	3,672,092	4,187,042	57,029.0	5 92	34 83	40 75
3	Jefferson	3,335	54 66	29 70	84 36	8,818.6	182,297	76,616	99,057	281,354	3,038.0	18 49	24 54	43 03
4	Lewis and Clarke	10,493	16 18	6 33	22 51	8,215.0	169,819	51,379	66,428	236,247	10,343.0	12 71	2 44	15 15
5	Madison	8,838	28 45	1 40	29 85	*12,166.2	*251,496	9,582	12,389	*263,887	5,264.5	16 49	07	16 56
	Total	114,858	9 95	42 68	52 63	55,286.7	1,142,876	3,791,502	4,902,034	6,044,912	86,576.5	7 20	32 52	39 82

* Estimated.

MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.				
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	
.....	.....	6,188	8,000	8,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
955.4	19,750	232	300	20,050	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
.....	.....	557,690	721,038	721,038	34.0	.....	.....	4,208	5,440	5,440	.....	.....	.....	.....	.....	3
955.4	19,750	564,110	729,338	749,088	34.0	.....	.....	4,208	5,440	5,440	.....	.....	.....	.....	.....	
.....	.....	152,597	197,293	197,293	1,567.0	.....	.....	101,621	131,386	131,386	.....	.....	40,487	52,346	52,346	1
.....	.....	49,178	63,582	63,582	3,212.0	223.2	4,600	163,548	210,158	214,958	.....	.....	.....	.....	.....	2
8,127.0	168,000	5,415	7,001	175,001	5,000.0	4,615.1	83,000	3,635	4,700	87,700	.....	.....	.....	.....	.....	3
8,210.7	169,750	1,328,944	1,718,192	1,887,922	14,448.0	1,620.3	33,494	584,433	755,613	789,107	203.2	4,200	21,321	27,566	31,766	4
16,337.7	337,750	1,536,134	1,986,068	2,323,798	24,227.0	5,867.6	121,294	852,237	1,101,857	1,223,151	203.2	4,200	61,808	79,912	84,112	
255.9	5,290	.....	.....	5,290	297.0	3,990.9	82,499	2,700	3,491	85,990	.....	.....	.....	.....	.....	1
619.2	12,800	1,237	1,600	14,400	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
339.7	6,629	29,309	37,894	44,523	.....	.....	.....	.....	.....	.....	11.3	234	1,629	1,330	1,564	3
.....	.....	27,000	34,908	34,908	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
1,100.5	22,749	.....	.....	22,749	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
420.9	8,701	124	160	8,861	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
2,717.2	56,169	57,670	74,562	130,731	297.0	3,990.9	82,499	2,700	3,491	85,990	11.3	234	1,629	1,330	1,564	
4,448.9	91,967	6,244	8,073	100,040	150.0	119.0	2,460	600	776	3,236	.....	.....	.....	.....	.....	1
1,566.5	32,383	13,310	17,208	49,591	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
*345.9	*7,150	.....	.....	*7,150	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
6,361.3	131,500	19,554	25,281	156,781	150.0	119.0	2,460	600	776	3,236	.....	.....	.....	.....	.....	
1,653.2	34,795	62	80	34,875	48.5	191.8	3,965	472	610	4,575	123.5	2,760	.....	.....	2,760	1
506.0	11,700	230	298	11,998	25.0	236.9	4,897	86	111	5,008	.....	.....	.....	.....	.....	2
3.5	72	.....	.....	72	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
1,946.1	40,230	.....	.....	40,230	2,500.0	2,455.6	50,749	.....	.....	50,749	190.0	3,721	.....	.....	3,721	4
4,108.8	86,797	292	378	87,175	2,573.5	2,883.7	59,611	558	721	60,332	313.5	6,481	.....	.....	6,481	

*Estimated.

PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced from ore raised prior to census year.				
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.
Ounces.	Dolls.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dolls.	Ozs.	Dollars.	Dollars.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	
955.4	19,750	564,110	729,338	749,088	34.0	.....	.....	4,208	5,440	5,440	.....	.....	.....	.....	.....	1
16,337.7	337,750	1,536,134	1,986,068	2,323,798	24,227.0	5,867.6	121,294	852,237	1,101,857	1,223,151	203.2	4,200	61,808	79,912	84,112	2
2,717.2	56,169	57,670	74,562	130,731	297.0	3,990.9	82,499	2,700	3,491	85,990	11.3	234	1,629	1,330	1,564	3
6,361.3	131,500	19,554	25,281	156,781	150.0	119.0	2,460	600	776	3,236	.....	.....	.....	.....	.....	4
4,108.8	86,797	292	378	87,175	2,573.5	2,883.7	59,611	558	721	60,332	313.5	6,481	.....	.....	6,481	5
30,570.4	631,946	2,177,760	2,815,627	3,447,573	28,281.5	12,861.2	265,864	860,203	1,112,285	1,378,149	528.0	10,915	63,437	81,242	92,157	

In Table CLVIII the following possible cause of error should be noted: In Summit Valley district, Deer Lodge county, owing to the incomplete character of some of the returns and the fact that many mines sell ore to both mills and smelters, there has been a possible duplication in estimating the bullion product. This overestimate, if such it really is, would not, however, amount to more than 500 tons, and is probably more than offset by the insufficiency of the data obtained. Considerable copper ore carrying silver goes out of the county for treatment, some of which could not be traced. Manganese ore, carrying some silver, is used by the smelters as flux, and is not accounted for in the "Tons raised"; but its yield should appear in the "Bullion produced".

Table CLIX, which is a condensation of Table CLVIII, gives the production of the deep mines of Montana by counties.

The following table shows the relative amounts of ore reduced in stamp-mills and by smelting works, with the average yield per ton and total contents in gold and silver in each case:

TABLE CLX.—MONTANA—ORE TREATED BY SMELTING WORKS AND AMALGAMATING MILLS.

	Ore treated.	Average yield per ton.			Bullion produced.				
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
Smelted	14,660.0	64	78 36	79 00	454.4	9,393	839,362	1,149,856	1,159,249
Milled	71,896.5	8 65	23 18	31 83	30,116.0	622,553	1,288,506	1,665,770	2,288,323
Total	86,576.5	7 30	32 52	39 82	30,570.4	631,946	2,177,760	2,815,626	3,447,572

HYDRAULIC AND PLACER MINES.

The gravel deposits of Montana form an important source of its wealth, and their product is known to be very considerable. The figures for this product, as explained above, have been assumed, in the absence of more reliable data, derived from direct information, and are:

Gold	ounces..	56,255.6
Value		$1,162,906

The counties from which hydraulic-mine returns were received are Deer Lodge, Meagher, Beaver Head, and Lewis and Clarke, the relative amount of production reported from each standing in the order in which they are named above.

The ores of Montana, like those of Colorado, contain considerable amounts of copper and lead, which cannot be neglected in considering its production of metals. The table below gives the amounts which could be traced, a portion of the copper having been reduced to copper oxide in Colorado. The figures below are for crude bullion which was not reduced to the metallic state within the territory. A certain amount of copper ore was shipped directly east from Montana, but its value or contents could not be ascertained.

TABLE CLXI.—MONTANA—CRUDE BULLION PRODUCED FOR THE YEAR ENDING MAY 31, 1880.

County.	Gross tons.	Lead.		Copper.		Gold.		Silver.		Total.
		Tons.	Dollars.	Tons.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
Beaver Head	1,568	1,132.5	101,925	186.25	74,500	.....	.....	562,574	727,352	903,777
Deer Lodge	525	.....	.....	420.00	168,000	343.5	7,101	160,300	207,252	382,353
Jefferson	83	81.5	7,335	.....	.....	232.0	6,863	30,378	39,276	53,474
Total	2,176	1,214.0	109,260	606.25	242,500	675.5	13,964	753,252	973,880	1,339,604

Lead, $90 per ton. Copper, $400 per ton.

NEW MEXICO.

Although during the census year the mines of New Mexico were attracting much attention, their practical development was awaiting the completion of the railroads which were about to intersect it. Its mining districts were many of them difficult and even dangerous of access, and it was almost impossible to ascertain in advance whether they had actually producing mines. The collection of statistics under these circumstances was peculiarly difficult, and the completeness of the material obtained was seriously impaired by the assassination of Colonel Charles Potter, the expert in charge of this territory. The data presented below do not necessarily give a fair idea of the capabilities of the territory as a mineral producer. It is believed, however, that the amount of ore produced during the census year and not accounted for below is not of very great amount.

The subjoined tables give the production of the deep mines by districts and by counties:

TABLE CLXII.—NEW MEXICO—PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
	Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dolls.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
DOÑA ANA.													
Hillsborough	718.5	82 65	.....	82 65	2,872.8	59,386	.....	.....	59,386	718.5	49 59	.....	49 59
Total	718.5	82 65	.....	82 65	2,872.8	59,386	.....	.....	59,386	718.5	49 59	.....	49 59
GRANT.													
Chloride Flat	4,550.0	.....	53 14	53 14	.....	.....	187,000	241,772	241,772	3,000.0	.....	29 31	29 31
Lone Mountain	1,000.0	.....	45 25	45 25	.....	.....	35,000	45,252	45,252	1,000.0	.....	31 99	31 99
Membres	1,658.0	.....	174 93	174 93	.....	.....	224,327	290,032	290,032	1,658.0	.....	148 68	148 68
Pinos Altos	860.0	29 45	31 93	61 38	1,225.0	25,323	21,240	27,461	52,784	860.0	15 96	.....	15 96
Silver Flat	1,000.0	.....	104 24	104 24	.....	.....	129,000	166,784	166,784	216.0	.....	120 37	120 37
Total	9,068.0	2 62	79 78	82 40	1,225.0	25,323	596,567	771,301	796,624	6,734.0	2 04	58 26	60 30
SANTA FÉ.													
Los Cerrillos	100.0	20 67	32 32	52 99	100.0	2,067	2,500	3,232	5,299	.....	.....	.....	.....
Total	100.0	20 67	32 32	52 99	100.0	2,067	2,500	3,232	5,299	.....	.....	.....	.....

County and district.	Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.				
	Gold.		Silver.		Total.		Gold.		Silver.		Total.
	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ozs.	Dollars.	Ounces.	Dollars.	Dollars.
DOÑA ANA.											
Hillsborough	1,723.7	35,632	.....	.....	35,632	.....	.....	.....	.....	.....	.....
Total	1,723.7	35,632	.....	.....	35,632	.....	.....	.....	.....	.....	.....
GRANT.											
Chloride Flat	.....	.....	83,000	87,917	87,917	1,550	.....	.....	87,000	86,624	86,624
Lone Mountain	.....	.....	24,675	31,903	31,903	.....	.....	.....	.....	.....	.....
Membres	.....	.....	190,670	246,517	246,517	.....	.....	.....	.....	.....	.....
Pinos Altos	663.6	13,722	.....	.....	13,722	.....	.....	.....	.....	.....	.....
Silver Flat	.....	.....	20,110	26,000	26,000	1,334	.....	.....	111,288	143,885	143,885
Total	663.6	13,722	308,455	392,337	406,059	2,884	.....	.....	178,288	230,509	230,509
SANTA FÉ.											
Los Cerrillos	.....	.....	.....	.....	.....	100	100	2,067	2,500	3,232	5,299
Total	.....	.....	.....	.....	.....	100	100	2,067	2,500	3,232	5,299

TABLE CLXIII.—NEW MEXICO—RECAPITULATION BY COUNTIES OF PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

County.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
	Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dolls.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
Doña Ana	718.5	69 65	.....	69 65	2,872.8	59,386	.....	.....	59,386	718.5	49 50	.....	49 50
Grant	9,668.0	2 62	79 78	82 40	1,225.0	25,333	596,567	771,381	796,634	6,734.0	3 64	55 26	60 30
Santa Fé	100.0	20 67	32 32	53 99	100.0	2,067	2,500	3,232	5,299	.....	.....	.....	.....
	10,486.5	8 29	73 86	82 14	4,197.8	86,776	599,067	774,333	861,109	7,452.5	6 62	52 65	59 27

County.	Bullion produced from ore raised during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.				
	Gold.		Silver.		Total.		Gold.		Silver.		Total.
	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
Doña Ana	1,723.7	35,632	.....	.....	35,632	.....	.....	.....	.....	.....	.....
Grant	663.8	13,722	303,455	392,237	405,959	2,934	.....	.....	178,288	230,509	230,509
Santa Fé	.....	.....	.....	.....	.....	100	100	2,067	2,500	3,232	5,299
	2,387.5	49,354	303,455	392,237	441,591	3,034	100	2,067	180,788	233,741	235,808

PLACER MINES.

Considerable rich placer ground is known to exist in New Mexico, but as yet but little gold has been obtained from it, owing to want of water. No record could be obtained of any product from such workings during the census year.

WYOMING.

Wyoming is surrounded on three sides by important mining regions, but has as yet developed but few mines within its borders. During the census year, as far as could be ascertained, the actual production of gold and silver has been confined to Sweetwater county, of which the production is given below:

TABLE CLXIV.—WYOMING—PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.			Bullion produced from ore raised and treated during census year.				
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.
	Tons.	Dolls.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Tons.	Dolls.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.
SWEETWATER.																		
California	145	*7 00	.....	*7 00	*49.1	*1,015	.....	.....	*1,015	145	5 14	.....	5 14	36.1	746	.....	.....	746
Miners' Delight	500	*33 33	.....	*33 33	*806.2	*16,666	.....	.....	*16,666	500	25 00	.....	25 00	604.7	12,500	.....	.....	12,500
Scattered	*198	*27 44	.....	*27 44	*263.5	*5,432	.....	.....	*5,432	*198	*20 58	.....	*20 58	197.1	4,075	.....	.....	4,075
Total	843	*27 42	.....	*27 42	*1,118.8	*23,113	.....	.....	*23,113	843	20 55	.....	20 55	837.9	17,321	.....	.....	17,321

* Estimated.

TABLE CLXV.—WYOMING—RECAPITULATION OF PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

County.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.			Bullion produced from ore raised and treated during census year.				
		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.
	Tons.	Dolls.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Tons.	Dolls.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.
Sweetwater	843	*27 42	.....	*27 42	1,118.1	*23,113	.....	.....	*23,113	843	20 55	.....	20 55	827.9	17,321	.....	.....	17,321
Total	843	27 42	.....	27 42	*1,118.1	*23,113	.....	.....	*23,113	843	20 55	.....	20 55	827.9	17,321	.....	.....	17,321

*Estimated.

STATISTICS OF THE EASTERN DIVISION.

The following tables, which are grouped together without comment, are compiled from schedule data furnished by Prof. Raphael Pumpelly, together with such information as could be gathered from other sources than the direct census investigation. Some unavoidable gaps occur in the tables, arising chiefly from the uncertainty regarding assay values to be expected where mining is conducted on the small scale. The estimates for Michigan and for Tennessee are not included in this exhibit, as they are derived exclusively from non-census material.

TABLE CLXVI.—EASTERN DIVISION—PRODUCTION OF DEEP

ALABAMA.

	County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	CLEBURNE.													
1	Scattered	100									100	10 00		10 00
	Total	100									100	10 00		10 00
	TALLADEGA.													
1	Township 19, range 6	24									24	12 50		12 50
	Total	24									24	12 50		12 50

GEORGIA.

	CHEROKEE.													
1	Hickory Flat	143	22 00		22 00	151.1	3,124			3,124	85	20 00		20 00
2	Third and second	120									120	5 00		5 00
	Total	263	22 00		22 00	151.1	3,124			3,124	205	11 22		11 22
	COBB.													
1	Scattered	100									100	4 00		4 00
	Total	100									100	4 00		4 00
	FORSYTH.													
1	Third and first	40									40	5 08		5 08
	Total	40									40	5 08		5 08
	HALL.													
1	Ninth	150									150	10 00		10 00
	Total	150									150	10 00		10 00
	LINCOLN.													
1	Scattered	550									550	10 88		10 88
	Total	550									550	10 88		10 88
	M'DUFFIE.													
1	Republican	100									100	6 00		6 00
	Total	100									100	6 00		6 00
	MERIWETHER.													
1	Lutherville	1,500									1,500	2 00		2 00
	Total	1,500									1,500	2 00		2 00

MAINE.

	HANCOCK.													
1	Goldsboro	100									100	20 00		20 00
2	West Sullivan	1,700	Traces.	30 00	30 00			39,448	51,000	51,000	300	Traces.	24 00	24 00
	Total	1,800	Traces.	30 00	30 00			39,448	51,000	51,000	400	7 50	18 00	25 50
	PENOBSCOT.													
1	Carmel	400	26 87	5 17	32 04	519.9	10,747	1,569	2,067	12,814				
	Total	400	26 87	5 17	32 04	519.9	10,747	1,569	2,067	12,814				
	YORK.													
1	Acton	50	6 75	32 30	39 05	16.3	337	1,249	1,615	1,952				
	Total	50	6 75	32 30	39 05	16.3	337	1,249	1,615	1,952				

MINES FOR THE YEAR ENDING MAY 31, 1880.

ALABAMA.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					
Gold.		Silver.		Total.		Gold.		Silver.		Total.	
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	
53.4	1,001			1,001							1
48.4	1,001			1,001							
14.5	300			300							1
14.5	300			300							

GEORGIA.

82.3	1,701			1,701	57	60.7	1,255			1,255	1
29.0	600			600							2
111.3	2,301			2,301	57	60.7	1,255			1,255	
19.3	399			399							1
19.3	399			399							
9.8	203			203							1
9.8	203			203							
72.6	1,501			1,501							1
72.6	1,501			1,501							
269.5	5,984			5,984							1
269.5	5,984			5,984							
29.0	599			599							1
29.0	599			599							
153.8	3,179			3,179							1
153.8	3,179			3,179							

MAINE.

145.1	3,000			3,000							1
		5,569	7,200	7,200	1,400			32,486	43,001	43,001	2
145.1	3,000	5,569	7,200	10,199	1,400			32,486	43,001	43,001	
					400	519.9	10,747	1,599	2,067	12,814	1
					400	519.9	10,747	1,599	2,067	12,814	
					50	16.3	337	1,249	1,615	1,952	1
					50	16.3	337	1,249	1,615	1,952	

TABLE CLXVI.—EASTERN DIVISION—PRODUCTION OF DEEP

NEW HAMPSHIRE.

	County and district.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	GRAFTON.													
1	Ammonoosuc	2,183									2,183	5 04	7 32	12 36
	Total	2,183									2,183	5 04	7 32	12 36

NORTH CAROLINA.

	DAVIDSON.													
1	Emmons township	20,000	17 50	2 50	20 00	16,981.2	*340,000	33,673	*50,000	*390,000				
2	Thomasville township	200									200	10 00		10 00
	Total	20,200	17 50	2 50	20 00	16,981.2	*340,000	33,673	*50,000	*390,000	200	10 00		10 00
	GASTON.													
1	Scattered	1,821									1,821	5 00		5 00
	Total	1,821									1,821	5 00		5 00
	GUILFORD.													
1	Scattered	10									10	2 87		2 87
	Total	10									10	2 87		2 87
	MECKLENBURG.													
1	Capp's Hill	450									450	65 00		65 00
2	Sixth district	10,920									10,920	6 00		6 00
	Total	11,370									11,370	8 33		8 33
	MOORE.													
1	Scattered	625									625	7 84	0 16	8 00
	Total	625									625	7 84	0 16	8 00
	NASH.													
1	Griffith township	60									60	20 07		20 07
	Total	60									60	20 07		20 07
	ROWAN.													
1	Scattered	1,200	9 00	3 00	12 00	522.4	10,799	2,784	3,599	14,398				
	Total	1,200	9 00	3 00	12 00	522.4	10,799	2,784	3,599	14,398				
	STANLEY.													
1	Scattered	500									500	4 00		4 00
	Total	500									500	4 00		4 00

SOUTH CAROLINA.

	ABBEVILLE.													
1	Bordeaux township													
	Total													
	COLLETON.													
1	Scattered													
	Total													

VIRGINIA.

	BUCKINGHAM.													
1	Curdsville	74									74	5 00		5 00
	Total	74									74	5 00		5 00
	CULPEPER.													
1	Scattered	90	40 00	1 40	41 40	174.5	3,607	97	125	3,732	5	35 80		35 80
	Total	90	40 00	1 40	41 40	174.5	3,607	97	125	3,732	5	35 80		35 80
	Additional production shown by mint receipts (a)													

* Estimated. a Receipts of Virginia gold at Philadelphia mint and New York assay office were $6,332.

MINES FOR THE YEAR ENDING MAY 31, 1880—Continued.

NEW HAMPSHIRE.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					
Gold.		Silver.		Total.		Gold.		Silver.		Total.	
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	
532.1	10,999	12,375	16,000	26,999							1
532.1	10,999	12,375	16,000	26,999							

NORTH CAROLINA.

98.8	2,001			2,001	20,000	16,931.2	*349,999	38,673	*50,000	*399,999	1
98.8	2,001			2,001	20,000	16,931.2	*349,999	38,673	*50,000	*399,999	
440.5	9,106			9,106							1
440.5	9,106			9,106							
13.9	287			287							1
13.9	287			287							
1,415.0	29,251			29,251							1
3,169.5	65,519			65,519							2
4,584.5	94,770			94,770							
237.0	4,899	77	100	4,999							1
237.0	4,899	77	100	4,999							
58.2	1,203			1,203							1
58.2	1,203			1,203							
					1,200	522.4	10,799	2,784	3,599	14,398	1
					1,200	522.4	10,799	2,784	3,599	14,398	
98.8	2,001			2,001							1
98.8	2,001			2,001							

SOUTH CAROLINA.

24.2	500			500							1
24.2	500			500							
290.2	5,999			5,999							1
290.2	5,999			5,999							

VIRGINIA.

17.9	370			370							1
17.9	370			370							
8.7	180			180	85	164.8	3,407	94	122	3,529	1
8.7	180			180	85	164.8	3,407	94	122	3,529	
434.3	8,771			8,771							

TABLE CLXVII.—EASTERN DIVISION—RECAPITULATION BY STATES AND COUNTIES

	State and county.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
	ALABAMA.													
1	Cleburne (a)	100	.....	.....	.....	.....	.....	.....	.....	.....	100	10 00	.....	10 00
2	Talladega (a)	24	.....	.....	.....	.....	.....	.....	.....	.....	24	12 50	.....	12 50
	Total	124	.....	.....	.....	.....	.....	.....	.....	.....	124	10 50	.....	10 50
	GEORGIA.													
1	Cherokee (a)	202	22 00	.....	22 00	151.1	3,124	.....	.....	3,124	205	11 22	.....	11 22
2	Cobb	100	.....	.....	.....	.....	.....	.....	.....	.....	100	4 00	.....	4 00
3	Forsyth	40	.....	.....	.....	.....	.....	.....	.....	.....	40	5 08	.....	5 08
4	Hall	150	.....	.....	.....	.....	.....	.....	.....	.....	150	10 00	.....	10 00
5	Lincoln	550	.....	.....	.....	.....	.....	.....	.....	.....	550	10 88	.....	10 88
6	McDuffie	100	.....	.....	.....	.....	.....	.....	.....	.....	100	6 00	.....	6 00
7	Meriwether	1,500	.....	.....	.....	.....	.....	.....	.....	.....	1,500	2 00	.....	2 00
	Total	2,792	.....	.....	.....	151.1	3,124	.....	.....	3,124	2,735	5 18	.....	5 18
	MAINE.													
1	Hancock (a)	1,800	.....	30 00	30 00	.....	.....	39,446	51,000	51,000	400	7 50	18 00	25 50
2	Penobscot	400	26 87	5 17	32 04	519.9	10,747	1,500	2,067	12,814	.....	.....	.....	.....
3	York	50	6 75	32 30	39 05	16.3	337	1,249	1,615	1,952	.....	.....	.....	.....
	Total	2,250	.....	.....	.....	536.2	11,084	42,294	54,682	65,766	400	7 50	18 00	25 50
	NEW HAMPSHIRE.													
1	Grafton	2,183	.....	.....	.....	.....	.....	.....	.....	.....	2,183	5 04	7 32	12 36
	NORTH CAROLINA.													
1	Davidson	20,200	17 50	2 50	20 00	16,931.2	*349,999	38,673	*50,000	*399,999	200	10 00	.....	10 00
2	Gaston	1,821	.....	.....	.....	.....	.....	.....	.....	.....	1,821	5 00	.....	5 00
3	Guilford	10	.....	.....	.....	.....	.....	.....	.....	.....	10	2 87	.....	2 87
4	Mecklenburg	11,370	.....	.....	.....	.....	.....	.....	.....	.....	11,370	8 33	.....	8 33
5	Moore	625	.....	.....	.....	.....	.....	.....	.....	.....	625	7 84	0 16	8 00
6	Nash	60	.....	.....	.....	.....	.....	.....	.....	.....	60	20 07	.....	20 07
7	Rowan	1,200	9 00	3 00	12 00	522.4	10,799	2,784	3,599	14,398	.....	.....	.....	.....
8	Stanley	500	.....	.....	.....	.....	.....	.....	.....	.....	500	4 00	.....	4 00
	Total	35,786	.....	.....	.....	17,453.6	360,798	41,457	53,599	414,397	14,586	7 83	.....	7 83
	SOUTH CAROLINA.													
1	Abbeville	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	Colleton	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	VIRGINIA.													
1	Buckingham	74	.....	.....	.....	.....	.....	.....	.....	.....	74	5 00	.....	5 00
2	Culpeper	90	40 09	1 40	41 49	174.5	3,607	97	125	3,732	5	35 80	.....	35 80
	Total from schedule data	164	.....	.....	.....	.....	.....	.....	.....	.....	79	6 96	.....	6 96
	Additional production shown by mint receipts	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Total	164	.....	.....	.....	174.5	3,607	97	125	3,732	.....	.....	.....	.....

*Estimated. a No assay values given.

OF PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					
Gold.		Silver.		Total.		Gold.		Silver.		Total.	
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	
48.4	1,001			1,001							
14.5	300			300							1
62.9	1,301			1,301							2
111.3	2,301			2,301	57	60.7	1,255			1,255	
19.3	399			399							1
9.8	203			203							2
72.6	1,501			1,501							3
288.5	5,964			5,964							4
29.0	599			599							5
153.8	3,179			3,179							6
											7
685.3	14,166			14,166	57	60.7	1,255			1,255	
145.1	2,999	5,569	7,200	10,199	1,400			32,436	42,001	42,001	1
					400	519.9	10,747	1,569	2,067	12,814	2
					50	16.2	337	1,249	1,615	1,952	3
145.1	2,999	5,569	7,200	10,199	1,850	536.2	11,084	35,334	45,683	56,767	
532.1	10,999	12,375	16,000	26,999							1
99.8	2,001			2,001	20,000	16,981.2	*349,999	38,673	*50,000	*399,999	
440.5	9,106			9,106							1
13.9	287			287							2
4,584.5	94,770			94,770							3
237.0	4,899	77	100	4,999							4
58.2	1,203			1,203							5
					1,200	522.4	10,799	2,784	3,599	14,398	6
99.8	2,001			2,001							7
											8
5,527.7	114,267	77	100	114,367	21,200	17,453.6	*360,798	41,457	*53,599	414,397	
24.2	500			500							
290.2	5,999			5,999							1
314.4	6,499			6,499							2
17.9	370			370							
8.7	180			180	85	164.8	3,407	94	122	3,529	1
26.6	550			550	85	164.8	3,407	94	122	3,529	2
424.3	8,771			8,771							
450.9	9,321			9,321	85	164.8	3,407	94	122	3,529	

*Estimated.

TABLE CLXVIII.—EASTERN DIVISION—PRODUCTION OF HYDRAULIC, PLACER, RIVER, AND BRANCH MINES FOR THE YEAR ENDING MAY 31, 1880.

GEORGIA.

County.	District.	Gold.			
		Totals by districts.		Totals by counties.	
		Ounces.	Dollars.	Ounces.	Dollars.
Cherokee	Fifteenth and second	10.9	225	10.9	225
Hall	510 G. M., 9 and 12 L	183.2	3,787	183.2	3,787
Lumpkin	Twelfth	1,501.6	32,901	2,838.3	58,673
Do	Twelfth and first	1,307.9	25,590		
Do	Thirteenth	8.8	182		
Union	Tenth	72.6	1,501	72.6	1,501
White	Third	81.1	1,676	129.5	2,677
Do	Fourth	48.4	1,001		
Total		3,234.5	66,863	3,234.5	66,863

NORTH CAROLINA.

Montgomery	El Dorado	34.9	721	207.6	4,291
Do	Scattered	172.7	3,570		
Pope	Scattered	19.1	395	19.1	395
Total		226.7	4,686	226.7	4,686

SOUTH CAROLINA.

Chesterfield	Scattered	316.4	6,541	316.4	6,541
Total		316.4	6,541	316.4	6,541

SILVER CONTAINED IN PLACER GOLD.

No account is taken by the miners of the silver alloyed with placer gold, unless in the exceptional cases where the value of the former is allowed for in the sale of the product, as in direct sales to the mints or United States assay offices. In the aggregate this silver forms a considerable item, which should be included in the total product, but which has usually been disregarded by statisticians.

The schedules of the experts contain data for a close estimate as to the average tenor of the placer product. A statement of the fineness in gold of samples from various localities is appended.

TABLE CLXIX.—SPECIMEN EXAMPLES OF PLACER GOLD.

CALIFORNIA.

County and locality.	Fineness in gold.	Remarks.	County and locality.	Fineness in gold.	Remarks.
BUTTE.			HUMBOLDT.		
Centerville	0.900		Gold Bluffs	0.940	
Cherokee Flat	0.970		Orleans Bar	0.726	Sold for $13 to $17 per ounce.
Magalia	0.900		PLACER.		
Morris Ravine	0.905—0.908		Bath	0.850	
Oroville	0.942		Dutch Flat	0.906—0.910	
CALAVERAS.			Gold Run	0.900	
Mokelumne Hill	0.850—0.900		Iowa Hill	0.784—0.814	
DEL NORTE.			Michigan Bluffs	0.925—0.960	
Bunker Hill Mine	0.897—0.925		PLUMAS.		
China Creek	0.900		Black Hawk Mine	0.924	
Happy Camp	0.875—0.925		Cook's Cañon	0.885	
Indian Creek	0.900		Gopher Hill	0.936	
Wingate Mine	0.944—0.950		Hungarian Hill	0.924	
EL DORADO.			Seneca	0.946	
Placerville	0.960		SHASTA.		
			Igo	0.885	

TABLE CLXIX.—SPECIMEN EXAMPLES OF PLACER GOLD—Continued.

CALIFORNIA—Continued.

County and locality.	Fineness in gold.	Remarks.
SISKIYOU.		
Callahan's Ranch	0.850	Sold for $17 75 per ounce.
Cottonwood	0.860	
Coyote Gulch	0.900—0.950	
Galena Hill	0.880—0.930	
Greenhorn	0.850	
Humbug Creek	0.809—0.865	
Indian Creek	0.835—0.960	Sold for $17 per ounce.
McAdams Creek	0.750—0.900	
Oro Fino	0.762	
Rattlesnake Creek	0.827	Sold for $16 50 per ounce.
Sawyer's Bar	0.850	
Sciad Valley	0.887—0.912	
Scott Valley	0.805	Sold for $16 to $16 25 per ounce.
South Fork Salmon	0.835	Sold for $16 75 per ounce.
Yreka	0.749—0.863	Sold for $15 to $17 12 per ounce.
STANISLAUS.		
La Grange	0.929	
TRINITY.		
Buckeye	0.890—0.900	
Cañon Creek	0.894—0.896	
Chapman's and Fisher's Mines	0.914—0.917	
Douglas	0.912	
Indian Creek	0.920	
Junction City	0.875—0.915	Sold for $18 per ounce.
Red Hill	0.910—0.917	
Trinity Center	0.900	
Trinity Mine	0.887—0.903	
Weaver	0.906—0.927	

COLORADO.

CHAFFEE.		
Hope	0.850	
CLEAR CREEK.		
Jackson	0.880	
LAKE.		
California	0.850—0.875	
PARK.		
Alma township	0.819	
ROUTT.		
Hahn's Peak	0.868	
SUMMIT.		
Bevan	0.750—0.820	
Spalding	0.850—0.900	

DAKOTA.

LAWRENCE.		
Bear Gulch	0.940	
Cape Horn	0.879	
PENNINGTON.		
Cañon	0.925	
Confederate	0.925—0.940	
Jenny and Strawberry	0.940	

GEORGIA.

CHEROKEE.		
Fifteenth District	0.927	Sold for $19 20 per ounce.
HALL.		
810 G. M. 9th and 12th districts	0.900—0.916	
LUMPKIN.		
Twelfth District	0.875—0.905	
Thirteenth District	0.902—0.902	
WHITE.		
Fourth District	0.945	
UNION.		
Tenth District	0.981	

IDAHO.

BOISÉ.		
Boisé Basin and vicinity	0.7906	Average of 413 lots.

MONTANA.

BEAVER HEAD.		
Bannock	0.935	
DEER LODGE.		
Gold Hill	0.950—0.956	
Henderson Gulch	0.925—0.927	
Independence	0.725—0.730	
McClellan's Gulch	0.900—0.920	Sold for $17 50 per ounce.
DEER LODGE—continued.		
Nelson	0.935—0.940	
Summit Valley	0.700	
LEWIS AND CLARKE.		
Last Chance	0.910	
MEAGHER.		
German	0.920—0.925	
Thompson's Gulch	0.945—0.950	

TABLE CLXIX.—SPECIMEN EXAMPLES OF PLACER GOLD—Continued.

OREGON.

BAKER.		
Amelia	0.810—0.900	
Blue Cañon	0.840—0.853	Sold for $16 50 per ounce.
Chicken Creek	0.725	Sold for $15 per ounce.
Humboldt Basin	0.789—0.806	Do. Do.
Mormon Basin	0.750	Sold for $16 per ounce.
Pocahontas	0.782—0.851	Sold for $15 50 to $17 per ounce.
Rye Valley	0.756	
Shasta	0.850—0.860	Sold for $16 50 per ounce.
Willow Creek	0.825	
CURRY.		
Sixes River	0.825	Sold for $17 per ounce.
DOUGLAS.		
Big Bend	0.925—0.950	Sold for $17 per ounce.
Cañonville	0.900—0.956	
Green Mountain	0.825—0.830	
GRANT.		
Cañon City	0.850—0.900	Sold for $17 60 per ounce.
Granite	0.750—0.761	
Marysville	0.805—0.887	Sold for $16 25 to $17 60 per ounce.
Rock Creek	0.857	Sold for $16 50 to $16 75 per ounce.
Trail Creek	0.850	
JACKSON.		
Applegate	0.850	
Ashland	0.846	
Coyote Creek	0.895—0.930	
Dry Diggings	0.975	
Fort Lane	0.870	Sold for $16 25 per ounce.
Forty-Nine	0.837	Sold for $16 50 per ounce.
Grass Creek	0.875—0.900	
Jacksas Creek	0.950	
Jacksonville	0.900	
Sam's Valley	0.825	
Sardine Creek	0.810—0.900	Sold for $16 75 per ounce.
Sterling	0.826—0.908	
Uniontown	0.804—0.820	Sold for $16 75 per ounce.
Wolf Creek	0.925	
JOSEPHINE.		
Althouse	0.865—0.875	Sold for $16 50 per ounce.
Cañon Creek	0.900	Sold for $17 per ounce.
Grass Creek	0.909—0.930	
Illinois	0.900	
Josephine	0.900	
Murphy	0.900	
Silver Creek	0.900	
Waldo	0.910—0.927	
Yank	0.907	
UMATILLA.		
Columbia River	0.740	Sold for $15 30 per ounce.
WASCO.		
Ochoco	0.711	

From the same sources the following condensed abstract has been prepared, showing the average fineness in gold and silver of the placer yield of several states and territories, with the number of specimen examples from which these averages are derived. The amount of base metal contained in the crude bullion varies from nothing to 0.020.

TABLE CLXX.—AVERAGE TENOR OF PLACER GOLD.

State or territory.	Number of examples.	Average fineness.	
		Gold.	Silver.
California	80	0.8836	0.1124
Colorado	9	0.8205	0.1755
Dakota	7	0.9235	0.0725
Georgia	10	0.9228	0.0732
Idaho	413	0.7866	0.2134
Montana	14	0.8991	0.1009
Oregon	77	0.8727	0.1233
Total	610		

From eighty examples of California placer dust and bullion an average fineness of 0.8836 is derived, a proportion slightly in excess of that stated in Dana's *Mineralogy*, where the fineness is quoted at 0.875 to 0.885, or an average of 0.880. It is possible that the census average is a trifle too high, owing to the natural tendency of producers to overestimate the fineness of their gold; but the slight difference between it and the figures given by Dana would not materially affect the general result.

The average for Idaho is of 413 lots of placer gold from Boisé basin, a district producing three-fourths of the total for the territory. This gold is of less fineness than that obtained in several other localities in Idaho, but the average stated will hold as a close approximation for the total.

There are three methods of obtaining from these data an average for the United States—neither of which is quite free from defects.

If the sum of the figures representing the average gold fineness for the several states and territories be divided by seven, the number of the states and territories from which reliable data as to fineness are obtainable, the quotient is 0.871257, which may be described as an average of geographical distribution. This, however, does not represent the average fineness of the whole actual amount produced, for by this method each state and territory is taken as an equal member in the calculation, without regard to the large difference in their several products. Thus, Georgia, with a product of $66,863, has as much weight in influencing the general average as California with a placer yield of $8,580,989, or 128 times as large.

Another mode is to give each individual example equal weight, disregarding territorial limits. Dividing the sum of fineness in gold of 610 specimen examples, 495,887, by 610, an average of 0.8129 is obtained. This gives a true average for the number of cases in which the fineness is definitely given in the schedules, but represents neither the average according to geographical distribution nor that of the whole product. In this way California, with a placer product nine and three-fourths times greater than that of Idaho, is largely overweighted by the latter, owing to the preponderance of examples furnished by Idaho in the census returns. The result is evidently too low.

The third and preferable method is to multiply the average fineness for each state and territory by the coefficient of the several yields, and then divide the sum of the products so obtained by the sum of the coefficients. This gives each not an equal but a just weight. The result is the average fineness of the total product without reference to the producing source. This principle is thus applied:

State or territory.	Average fineness in gold.		Yield of placer gold in millions of dollars.		Resultants.
California	0.8836	×	8.581	=	7.5821716
Colorado	0.8205	×	0.102	=	0.0836910
Dakota	0.9235	×	0.051	=	0.0470985
Georgia	0.9228	×	0.067	=	0.0618276
Idaho	0.7806	×	0.880	=	0.6869280
Montana	0.8951	×	1.163	=	1.0410013
Oregon	0.8727	×	0.926	=	0.8081202
			11.770		10.3108382

$$\text{Total average gold fineness} = \frac{10.3108382}{11.770} = 0.87602$$

The proportionate contents in silver and in base metal are similarly ascertained. By using the figures representing the average tenor of the placer gold for each of the states and territories for which reliable data are obtainable, and assuming the general average deduced from them for the cases in which the returns are defective, the probable total silver contents may readily be calculated. It is found that the 580,766.6 ounces of fine gold were associated with 80,177.3 ounces of fine silver and 2,753.2 ounces of base metal, making the total weight of the crude placer gold 663,697.1 ounces. In mint value the silver contents were worth only $103,661 as against $12,005,511 for the gold. Thus while the ratio of silver to gold products was 1:7.2437 in weight, it was only 1:115.8153 in assay value. At the market rates the value of this placer silver, if any account were taken of it, would be considerably less, or a ratio of about 1:131. The loss to the miners in the price paid for the actual gold contents of the placer dust, when sold in small quantities to local dealers, is so much greater than the whole value of the silver contents, that the latter does not appear to them a matter of any consequence. The amount of silver alloyed with the placer gold of the several states and territories is shown in the accompanying table:

TABLE CLXXI.—CONTENTS AND MINT VALUE OF CRUDE PLACER GOLD.

State or territory.	Contents of placer gold.				Mint value.		
	Fine gold.	Fine silver.	Base metal.	Total crude metal.	Gold.	Silver.	Total.
	Ounces.	Ounces.	Ounces.	Ounces.	Dollars.	Dollars.	Dollars.
Alaska	287.9	*39.4	1.3	328.6	5,951	*51	6,002
Arizona	*1,451.2	*198.8	*6.6	*1,656.6	*29,999	*257	*30,256
California	415,105.0	52,804.2	1,879.1	469,788.3	8,580,982	68,271	8,649,253
Colorado	4,921.9	1,052.8	24.0	5,998.6	101,745	1,361	103,106
Dakota	2,460.3	193.1	0.2	2,653.6	50,859	250	51,109
Georgia	3,234.5	256.6	14.0	3,505.1	66,863	332	67,195
Idaho	42,562.8	11,633.1	327.1	54,512.9	879,644	15,040	894,684
Montana	56,255.6	6,341.4	251.4	62,848.4	1,162,906	8,199	1,171,105
Nevada	*2,418.7	*331.3	*11.0	*2,761.1	*49,999	*428	*50,427
North Carolina	*228.7	*31.0	*1.0	*258.8	*4,686	*40	*4,726
Oregon	44,811.5	6,331.2	205.4	51,348.1	926,336	8,186	934,522
South Carolina	316.4	*43.3	*1.4	*361.2	6,541	*56	*6,597
Utah	967.5	*132.5	*4.4	*1,104.4	20,000	*171	*20,171
Washington	5,756.6	*788.6	*26.3	*6,571.4	119,000	*1,019	*120,019
Total	580,766.6	80,177.3	2,753.2	663,697.1	12,005,511	103,661	12,109,172

*Estimated.

RÉSUMÉ OF PRODUCTION STATISTICS.

The statements of ore raised, its average assay value per ton and total assay valuation; ore treated, of that which was raised during the year, its average yield per ton and total bullion product; ore which remained on the dumps at the close of the census year and its assay value; and bullion produced from ore raised prior to the census year, including old tailings reworked, are grouped into the following comprehensive exhibit of the deep mines:

TABLE CLXXII.—UNITED STATES—PRODUCTION OF

	State or territory.	Ore raised during census year.	Average assay value per ton.			Total assay value of ore raised during census year.					Ore raised and treated.	Average yield per ton.		
			Gold.	Silver.	Gold and silver.	Gold.		Silver.		Total.		Gold.	Silver.	Gold and silver.
		Tons.	Dolls.	Dolls.	Dolls.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
		2,216,417.61	a12 68	a25 64	a38 32	1,289,990.5	26,666,468	41,193,494	53,259,070	79,925,538	1,884,426.25	a10 36	a20 43	a30 81
1	Alabama (b)	124.00									124.00	10 50		10 50
2	Alaska													
3	Arizona	48,252.50	*8 70	*89 19	*97 89	*20,312.3	*419,892	*3,328,753	*4,303,746	*4,723,638	*25,728.25	*7 01	*86 24	*93 25
4	Arkansas													
5	California	544,241.00	18 84	2 84	21 68	495,902.1	10,252,446	1,194,084	1,543,832	11,796,278	435,301.00	16 10	2 00	18 10
6	Colorado	336,360.00	8 58	55 26	63 94	149,548.2	3,091,435	15,233,414	19,695,282	22,786,717	330,580.50	6 89	49 20	56 09
7	Connecticut													
8	Dakota	536,748.00	7 71	33	8 04	200,313.9	4,140,856	136,853	176,937	4,317,793	496,130.00	6 33	14	6 47
9	Delaware													
10	District of Columbia													
11	Florida													
12	Georgia (b)	2,792.00				151.1	3,124			3,124	2,735.00	5 18		5 18
13	Idaho	35,825.50	28 97	24 52	53 49	50,212.4	1,037,982	679,387	878,379	1,916,361	28,029.75	21 16	15 91	37 07
14	Illinois													
15	Indiana													
16	Indian Territory													
17	Iowa													
18	Kansas													
19	Kentucky													
20	Louisiana													
21	Maine (b)	2,250.00				536.2	11,084	42,294	54,682	65,766	400.00	7 50	18 00	25 50
22	Maryland													
23	Massachusetts													
24	Michigan (c)													
25	Minnesota													
26	Mississippi													
27	Missouri													
28	Montana	114,858.00	9 95	42 68	52 63	55,298.7	1,142,878	3,791,502	4,902,034	6,044,912	86,576.50	7 30	32 52	39 82
29	Nebraska													
30	Nevada	336,052.33	13 62	41 06	56 68	269,077.4	5,562,323	11,308,738	14,621,067	20,183,390	346,231.00	12 35	33 47	45 82
31	New Hampshire (b)	2,183.00									2,183.00	5 04	7 32	12 36
32	New Jersey													
33	New Mexico	10,486.50	8 28	73 88	82 14	4,197.8	86,776	509,067	774,533	861,309	7,452.50	6 62	52 65	59 27
34	New York													
35	North Carolina (b)	35,786.00				17,453.6	360,798	41,457	53,599	414,397	14,586.00	7 83	Trace.	7 83
36	Ohio													
37	Oregon	14,087.00	16 86	5 35	22 21	11,491.7	237,555	58,292	75,366	312,921	13,772.00	12 44	1 30	13 74
38	Pennsylvania													
39	Rhode Island													
40	South Carolina (b)													
41	Tennessee													
42	Texas													
43	Utah	154,827.78	1 75	39 91	41 66	13,088.5	270,563	4,779,556	6,179,488	6,450,051	93,116.75	1 98	31 38	33 36
44	Vermont													
45	Virginia (b)	164.00				174.5	3,607	97	125	3,732				
46	Washington	537.00	41 04	Trace.	41 04	1,066.0	22,038			22,038	537.00	31 28	Trace.	31 28
47	West Virginia													
48	Wisconsin													
49	Wyoming	843.00	*27 42		*27 42	1,118.1	23,113			23,113	843.00	29 55		29 55

* Estimated.
a Average calculated without including partial data from eastern and southern states.
b No further schedule data.

DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

Bullion produced from ore raised and treated during census year.					Ore raised but not treated.	Assay value of ore raised during census year and remaining on hand at close of year.					Bullion produced during census year from ore previously raised.					
Gold.		Silver.		Total.		Gold.		Silver.		Total.	Gold.		Silver.		Total.	
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ozs.	Dollars.	Ounces.	Dollars.	Dollars.	Ozs.	Dollars.	Ounces.	Dollars.	Dollars.	
972, 582. 9	20, 105, 073	30, 577, 033	39, 533, 037	59, 638, 110	182, 346. 00	89, 033. 8	1, 840, 493	5, 277, 522	6, 823, 308	8, 663, 801	61, 391. 7	1, 269, 079	1, 140, 272	1, 474, 259	2, 743, 338	
62. 9	1, 301	.....	.....	1, 301	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
*8, 725. 2	*180, 366	*1, 716, 176	*2, 218, 844	*2, 399, 210	22, 524. 25	8, 667. 7	179, 176	1, 209, 472	1, 563, 726	1, 742, 902	77. 4	1, 600	82, 546	106, 724	108, 324	3
402, 469. 5	8, 319, 786	828, 536	1, 071, 215	9, 391, 001	8, 940. 00	3, 814. 3	78, 850	7, 281	9, 414	88, 264	12, 102. 2	250, 173	8, 818	11, 401	261, 574	4
110, 181. 3	2, 277, 649	12, 879, 551	16, 264, 101	18, 541, 750	25, 779. 50	6, 007. 9	124, 194	1, 631, 644	2, 109, 553	2, 233, 747	15, 504. 4	320, 504	219, 516	283, 812	604, 316	5
151, 837. 1	3, 138, 751	54, 577	70, 563	3, 209, 314	40, 618. 00	17, 763. 3	366, 994	25, 404	32, 845	399, 839	5, 622. 7	116, 233	.....	.....	116, 233	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
685. 3	14, 166	.....	.....	14, 166	57. 00	60. 7	1, 255	.....	.....	1, 255	.....	.....	.....	.....	.....	11
28, 689. 9	593, 073	344, 969	446, 010	1, 039, 083	7, 705. 75	16, 411. 6	339, 258	283, 622	366, 695	705, 953	325. 5	6, 906	3, 707	3, 500	10, 406	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
145. 1	2, 999	5, 569	7, 200	10, 199	1, 850. 00	536. 2	11, 084	85, 334	45, 683	56, 767	.....	.....	.....	.....	.....	21
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22
.....	.....	*20, 000	*25, 858	*25, 858	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	24
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	26
30, 570. 4	631, 946	2, 177, 760	2, 815, 627	3, 447, 573	28, 281. 50	12, 861. 2	265, 864	860, 303	1, 112, 285	1, 378, 149	538. 0	10, 915	63, 637	81, 342	92, 157	27
206, 907. 4	4, 277, 156	8, 964, 562	11, 590, 282	15, 867, 438	9, 721. 00	3, 954. 4	81, 745	462, 980	598, 587	680, 332	27, 142. 6	*561, 087	649, 669	*839, 957	*1, 401, 044	28
532. 1	10, 999	12, 375	16, 000	26, 999	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	29
2, 387. 5	49, 354	303, 455	392, 337	441, 691	3, 034. 00	100. 0	2, 067	180, 788	233, 741	235, 808	.....	.....	.....	.....	.....	30
5, 527. 7	114, 267	77	100	114, 367	21, 200. 00	17, 453. 6	*360, 726	41, 457	*53, 589	414, 397	.....	.....	.....	.....	.....	31
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	32
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	33
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	34
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35
8, 285. 5	171, 276	13, 880	17, 946	189, 222	315. 00	1, 663. 6	22, 400	31, 634	40, 900	63, 300	4. 2	89	1, 285	1, 661	1, 750	36
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	37
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	38
314. 4	6, 499	.....	.....	6, 499	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	39
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	40
d96. 7	d1, 998	.....	.....	d1, 998	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	41
13, 063. 4	270, 045	3, 555, 538	4, 596, 954	4, 866, 999	12, 145. 00	164. 5	3, 401	507, 509	656, 158	659, 559	74. 6	1, 542	112, 896	145, 962	147, 504	42
d450. 9	d9, 321	.....	.....	d9, 321	85. 00	164. 8	3, 407	94	122	3, 529	.....	.....	.....	.....	.....	43
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	44
812. 7	16, 800	.....	.....	16, 800	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	45
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	46
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	47
837. 9	17, 321	.....	.....	17, 321	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	48
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49

* Estimated.
c Estimated from receipts at New York assay-office; does not include bullion from Silver Islet (which is in Canada).
d Actual receipts at Philadelphia mint and New York assay-office.

TABLE CLXXIII.—BULLION PRODUCT OF THE UNITED

	State or territory.	DEEP MINES.									
		From ore raised and treated during census year.					From ore raised prior to, but treated during, census year.				
		Gold.		Silver.		Total.	Gold.		Silver.		Total.
		Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.
	Total	972,562.9	20,105,073	30,577,025	39,533,037	59,638,110	61,391.7	1,269,079	1,140,272	1,474,259	2,743,338
1	Alabama	62.9	1,301	.....	.....	1,301	.....	.....	.....	.....	.....
2	Alaska	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	Arizona	8,725.2	180,368	*1,716,176	*2,218,844	*2,399,210	77.4	1,600	82,546	106,724	108,324
4	California	402,469.5	8,319,786	823,536	1,071,215	9,391,001	12,103.2	250,173	8,818	11,401	261,574
5	Colorado	110,181.3	2,277,649	12,579,551	16,264,101	18,541,750	15,504.4	320,504	219,516	283,812	604,316
6	Dakota	151,837.1	3,138,751	54,577	70,563	3,209,314	5,622.7	116,233	.....	.....	116,233
7	Georgia	685.3	14,166	.....	.....	14,166	.....	.....	.....	.....	.....
8	Idaho	28,669.9	592,973	344,969	446,010	1,038,983	335.5	6,936	2,707	3,500	10,436
9	Maine	145.1	2,999	5,569	7,200	10,199	.....	.....	.....	.....	.....
10	Michigan	.....	.....	*20,000	*25,858	*25,858	.....	.....	.....	.....	.....
11	Montana	30,570.4	631,946	2,177,780	2,815,627	3,447,573	528.0	10,915	63,837	81,242	92,157
12	Nevada	206,907.4	4,277,156	8,964,562	11,590,282	15,867,438	27,142.6	561,087	649,608	839,957	1,401,044
13	New Hampshire	532.1	10,999	12,375	16,000	26,999	.....	.....	.....	.....	.....
14	New Mexico	2,387.5	49,354	303,455	392,337	441,691	.....	.....	.....	.....	.....
15	North Carolina	5,527.7	114,267	77	100	114,367	.....	.....	.....	.....	.....
16	Oregon	8,285.5	171,276	13,880	17,946	189,222	4.3	89	1,285	1,661	1,750
17	South Carolina	314.4	6,499	.....	.....	6,499	.....	.....	.....	.....	.....
18	Tennessee	96.7	1,998	.....	.....	1,998	.....	.....	.....	.....	.....
19	Utah	13,063.4	270,045	3,555,538	4,596,954	4,866,999	74.6	1,542	112,895	145,962	147,504
20	Virginia	450.9	9,321	.....	.....	9,321	.....	.....	.....	.....	.....
21	Washington	812.7	16,800	.....	.....	16,800	.....	.....	.....	.....	.....
22	Wyoming	837.9	17,321	.....	.....	17,321	.....	.....	.....	.....	.....

* Estimated.

STATES FOR THE YEAR ENDING MAY 31, 1880.

DEEP MINES—continued.					PLACER MINES.					ALL MINES.					
Total from deep mines.															
Gold.		Silver.		Total.	Gold.		Silver.		Total.	Gold.		Silver.		Total.	
Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Ounces.	Dollars.	Ozs.	Dolls.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	
1,033,974.6	21,374,152	31,717,297	41,007,298	62,381,448	580,766.6	12,005,511	80,177.3	103,661	12,109,172	1,614,741.2	33,379,663	31,797,474.3	41,110,957	74,490,620	
62.9	1,301			1,301						62.9	1,301			1,301	1
					287.9	5,951	*39.4	*51	6,002	287.9	5,951	39.4	51	6,002	2
*8,802.6	*181,993	*1,796,722	*2,325,568	*2,507,534	*1,451.2	*29,999	*196.8	*257	*30,256	*10,253.8	*211,992	*1,796,920.8	*2,325,825	*2,537,790	3
414,571.7	8,569,959	857,354	1,662,416	9,652,375	415,105.0	8,580,962	52,804.2	68,271	8,649,233	829,676.7	17,150,941	890,158.2	1,150,987	18,301,928	4
125,685.7	2,598,153	12,799,067	16,547,913	19,146,066	4,321.0	101,745	1,052.8	1,361	103,106	130,007.6	2,699,898	13,800,119.8	16,549,274	19,249,172	5
157,459.8	3,254,984	54,577	70,562	3,325,547	2,469.8	50,959	198.1	250	51,109	159,929.1	3,305,943	54,779.1	70,812	3,376,656	6
685.3	14,166			14,166	3,234.5	66,863	256.6	332	67,195	3,919.8	81,029	256.6	332	81,361	7
29,025.4	600,009	347,676	449,510	1,049,519	42,552.8	878,644	11,023.1	13,040	894,684	71,578.2	1,479,653	358,699.1	464,550	1,944,203	8
145.1	2,999	5,569	7,200	10,199						145.1	2,999	5,569.0	7,200	10,199	9
		*20,000	*25,858	*25,858								*20,000.0	*25,858	*25,858	10
31,008.4	642,861	2,240,597	2,898,869	3,539,730	56,253.6	1,162,966	6,341.4	8,199	1,171,165	87,262.0	1,805,767	2,246,939.4	2,905,068	4,710,835	11
234,050.0	4,838,343	9,614,230	12,430,239	17,268,482	*2,418.7	*49,999	*281.3	*428	*50,427	236,468.7	4,888,342	9,614,581.3	12,430,667	17,318,909	12
532.1	10,999	12,375	16,000	26,999						532.1	10,999	12,375.0	16,000	26,999	13
2,387.5	49,354	303,455	392,237	441,591						2,387.5	49,354	303,455.0	392,237	441,591	14
5,527.7	114,267	77	100	114,367	*238.7	*4,638	*31.0	*40	*4,726	5,754.4	118,993	108.0	140	119,093	15
8,269.8	171,365	15,165	19,607	190,972	44,811.5	926,396	6,251.2	8,186	934,582	53,101.3	1,097,761	21,496.2	27,793	1,125,494	16
314.4	6,499			6,499	316.4	*6,541	*42.3	*56	*6,597	630.8	13,040	42.3	56	13,096	17
98.7	1,998			1,998						98.7	1,998			1,998	18
13,138.0	271,567	3,668,433	4,742,916	5,014,503	997.5	*20,000	*132.5	*171	*20,171	14,105.5	291,567	3,668,565.5	4,743,087	5,034,674	19
450.9	9,321			9,321						450.9	9,321			9,321	20
812.7	16,800			16,800	5,756.6	*119,000	*768.6	*1,019	*120,019	6,569.3	135,800	768.6	1,019	136,819	21
837.9	17,321			17,321						837.9	17,321			17,321	22

Estimated.

From Table CLXXII some interesting relations are deducible. It appears that of the ore mined during the census year 91.39 per cent. in tonnage was treated at the reduction works and 8.61 per cent. was left on the dumps. The average result of working treatment, as compared with assay value, was 81.86 per cent. of the gold contents, 79.68 per cent. of the silver, and 80.40 per cent. in all. Notwithstanding the large number of estimated amounts entering into the calculation, these results are probably a very close approximation to the truth.

The highest average yield was from the Arizona ores, amounting to $7 01 gold, $86 24 silver, and $93 25 total per ton. Of the localities producing any considerable amount of bullion, Dakota, with an average of $6 33 gold, $0 14 silver, and $6 47 total per ton, appears as the region where low-grade gold ores are worked to the best advantage, the percentage of yield to assay value being 82.10 per cent. in gold, 42.42 per cent. in silver, and 80.47 per cent. total.

The total product of each state and territory, including the silver contents of placer gold, appears in Table CLXXIII, which shows the aggregate bullion output of the United States for the census year.

The relative quota contributed by each of the three great arbitrary divisions into which the country has been apportioned is indicated in the accompanying abstracts, from which it will be seen that the Pacific division furnishes 75.68 per cent. of the gold, 51.43 per cent. of the silver, and 62.30 per cent. of the total. The division of the Rocky mountains yields 23.60 per cent. of the gold, 48.45 per cent. of the silver, and 37.31 per cent. of the total. The product of the Eastern division represents 0.72 per cent. of the gold, 0.12 per cent. of the silver, and 0.39 per cent. of the total.

TABLE CLXXIV.—PRODUCTION BY GEOGRAPHICAL DIVISIONS.

PACIFIC DIVISION.

State or territory.	Product.		
	Gold.	Silver.	Total.
Alaska	$5,951	$51	$6,002
Arizona	211,965	2,325,825	2,537,790
California	17,150,941	1,150,887	18,301,828
Idaho	1,479,653	464,550	1,944,203
Nevada	4,888,242	12,430,667	17,318,909
Oregon	1,697,701	27,793	1,725,494
Utah	291,587	4,743,087	5,034,674
Washington	135,800	1,019	136,819
Total	25,961,840	21,143,879	46,405,719

DIVISION OF THE ROCKY MOUNTAINS.

Colorado	$2,699,898	$16,549,274	$19,249,172
Dakota	3,305,843	70,813	3,376,656
Montana	1,805,767	2,905,068	4,710,835
New Mexico	49,354	392,237	441,591
Wyoming	17,321		17,321
Total	7,878,183	19,917,492	27,795,675

EASTERN DIVISION.

Alabama	$1,301		$1,301
Georgia	81,029	$332	81,361
Maine	2,999	7,200	10,199
Michigan		25,858	25,858
New Hampshire	10,999	16,000	26,999
North Carolina	118,953	140	119,093
South Carolina	13,040	56	13,096
Tennessee	1,998		1,998
Virginia	9,321		9,321
Total	239,640	49,586	289,226

SUMMARY.

Pacific division	$25,961,840	$21,143,879	$46,405,719
Division of the Rocky mountains	7,878,183	19,917,492	27,795,675
Eastern division	239,640	49,586	289,226
Total	33,379,663	41,110,957	74,490,620

The bullion product of the deep mines of the United States for the year under review amounted to 35 tons 900 pounds avoirdupois (1,033,974.6 ounces troy) of fine gold, and 1,087 tons 900 pounds avoirdupois (31,717,297 ounces troy) of fine silver. That of the placer mines weighed 19 tons 1,824 pounds avoirdupois (580,766.6 ounces troy) in fine gold, with which were alloyed 2 tons 1,498 pounds avoirdupois (80,177.3 ounces troy) of silver. The total weight of fine bullion was no less than 55 tons 724 pounds avoirdupois (1,614,741.2 ounces troy) of gold, and 1,090 tons 398 pounds avoirdupois (31,797,474.3 ounces troy) of silver. These huge figures may be better grasped, perhaps, by considering that the gold represents five ordinary car-loads, while a train of 109 freight cars of the usual capacity would be required to transport the silver. Historians have stated that during the early Spanish occupation whole galleons were freighted exclusively with silver from the mines of Mexico and Peru. This would hardly seem to be an exaggeration, in view of the fact that the present annual product of the United States would suffice to form the full cargo of a large modern vessel.

COMPARISONS.

The relative proportion of placer gold to that produced by the deep mines; the percentage in each class of product of the precious metals from the several mining regions of the United States; the average yield per square mile and per capita in different localities, and the rank of the states and territories in productiveness, are indicated in the following exhibits:

TABLE CLXXV.—PERCENTAGE OF PLACER GOLD AND GOLD FROM DEEP MINES IN TOTAL GOLD PRODUCT.

State or territory.	Hydraulic, placer, drift, and river mines.	Deep mines.	State or territory.	Hydraulic, placer, drift, and river mines.	Deep mines.
Alabama		100.00	New Mexico		100.00
Alaska	100.00		North Carolina	3.94	96.06
Arizona	14.15	85.85	Oregon	84.39	15.61
California	50.03	49.97	South Carolina	50.16	49.84
Colorado	3.77	96.23	Tennessee		100.00
Dakota	1.54	98.46	Utah	6.86	93.14
Georgia	82.52	17.48	Virginia		100.00
Idaho	59.45	40.55	Washington	87.63	12.37
Maine		100.00	Wyoming		100.00
Montana	64.40	35.60			
Nevada	1.02	98.98	United States (including Alaska)	36.06	64.03
New Hampshire		100.00			

TABLE CLXXVI.—RELATIVE PRODUCTION OF THE STATES AND TERRITORIES.

State or territory.	Gold.			Silver.	Total.
	Placer mines.	Deep mines.	Total gold.		
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Alabama		0.01	0.01		
Alaska	0.05		0.02		
Arizona	0.25	0.85	0.63	5.66	3.40
California	71.47	40.09	51.38	2.80	24.57
Colorado	0.85	12.16	8.09	40.25	25.84
Dakota	0.43	15.23	9.90	0.17	4.53
Georgia	0.56	0.07	0.24		0.11
Idaho	7.33	2.81	4.43	1.13	2.61
Maine		0.01	0.01	0.02	0.01
Michigan				0.06	0.03
Montana	9.09	3.01	5.41	7.07	6.24
Nevada	0.42	22.64	14.64	30.24	23.27
New Hampshire		0.05	0.03	0.04	0.04
New Mexico		0.23	0.15	0.95	0.59
North Carolina	0.04	0.53	0.36		0.16
Oregon	7.71	0.80	3.29	0.07	1.51
South Carolina	0.05	0.03	0.04		0.02
Tennessee		0.01	0.01		
Utah	0.17	1.27	0.87	11.54	6.76
Virginia		0.04	0.03		0.01
Washington	0.99	0.06	0.41		0.18
Wyoming		0.06	0.05		0.02
Total	100.00	100.00	100.00	100.00	100.00

TABLE CLXXVII.—AVERAGE PRODUCT OF GOLD AND SILVER PER SQUARE MILE AND PER CAPITA.

States and territories.	Average product.					
	Per square mile.			Per capita.		
	Gold.	Silver.	Total.	Gold.	Silver.	Total.
Alabama	$0.02	.....	$0.02	$0.001	.....	$0.001
Alaska	0.01	.....	0.01	0.20	.....	0.20
Arizona	1.87	$20.58	22.45	5.24	$57.51	62.75
California	108.30	7.27	115.57	19.83	1.33	21.16
Colorado	25.98	159.24	185.22	13.89	85.16	99.05
Dakota	22.17	0.48	22.65	24.46	0.52	24.98
Georgia	1.36	0.01	1.37	0.05	0.0002	0.05
Idaho	17.45	5.48	22.93	45.37	14.25	59.62
Maine	0.09	0.22	0.31	0.005	0.011	0.016
Michigan	.....	0.44	0.44	.....	0.02	0.02
Montana	12.36	19.89	32.25	46.11	74.19	120.30
Nevada	44.16	112.29	156.45	78.51	199.63	278.14
New Hampshire	1.18	1.72	2.90	0.03	0.05	0.08
New Mexico	0.40	3.20	3.60	0.41	3.28	3.69
North Carolina	2.28	0.003	2.28	0.08	0.0001	0.08
Oregon	11.43	0.29	11.72	6.28	0.16	6.44
South Carolina	0.43	.....	0.43	0.01	.....	0.01
Tennessee	0.05	.....	0.05	0.001	.....	0.001
Utah	3.43	55.82	59.25	2.03	32.94	34.97
Virginia	0.22	.....	0.22	0.006	.....	0.006
Washington	1.96	0.015	1.98	1.81	.....	1.81
Wyoming	0.18	.....	0.18	0.83	.....	0.83
United States (including Alaska)	9.31	11.44	20.75	0.66	0.82	1.48
United States (not including Alaska)	11.03	13.59	24.62	0.66	0.82	1.48
United States (including only the states and territories producing gold and silver, with Alaska)	14.68	18.02	32.70	2.60	3.20	5.80
United States (including only the states and territories producing gold and silver, and not including Alaska)	19.44	23.94	43.38	2.61	3.21	5.82
Average for Colorado, California, Nevada, Utah, Montana, Dakota, Arizona, and Idaho	33.47	42.74	76.21	21.04	26.87	47.91

TABLE CLXXVIII.—RANK OF THE STATES AND TERRITORIES IN PRODUCTION OF THE PRECIOUS METALS.

In actual product.			In product per square mile.			In product per capita.		
Gold.	Silver.	Total.	Gold.	Silver.	Total.	Gold.	Silver.	Total.
1. California.	1. Colorado.	1. Colorado.	1. California.	1. Colorado.	1. Colorado.	1. Nevada.	1. Nevada.	1. Nevada.
2. Nevada.	2. Nevada.	2. California.	2. Nevada.	2. Nevada.	2. Nevada.	2. Montana.	2. Colorado.	2. Montana.
3. Dakota.	3. Utah.	3. Nevada.	3. Colorado.	3. Utah.	3. California.	3. Idaho.	3. Montana.	3. Colorado.
4. Colorado.	4. Montana.	4. Utah.	4. Dakota.	4. Arizona.	4. Utah.	4. Dakota.	4. Arizona.	4. Arizona.
5. Montana.	5. Arizona.	5. Montana.	5. Idaho.	5. Montana.	5. Montana.	5. California.	5. Utah.	5. Idaho.
6. Idaho.	6. California.	6. Dakota.	6. Montana.	6. California.	6. Idaho.	6. Colorado.	6. Idaho.	6. Utah.
7. Oregon.	7. Idaho.	7. Arizona.	7. Oregon.	7. Idaho.	7. Dakota.	7. Oregon.	7. New Mexico.	7. Dakota.
8. Utah.	8. New Mexico.	8. Idaho.	8. Utah.	8. New Mexico.	8. Arizona.	8. Arizona.	8. California.	8. California.
9. Arizona.	9. Dakota.	9. Oregon.	9. N. Carolina.	9. Dakota.	9. Oregon.	9. Utah.	9. Dakota.	9. Oregon.
10. Washington.	10. Michigan.	10. New Mexico.	10. Washington.	10. Michigan.	10. New Mexico.	10. Washington.	10. Oregon.	10. New Mexico.
11. N. Carolina.	11. Oregon.	11. Washington.	11. Arizona.	11. Maine.	11. N. Hampshi'e.	11. Wyoming.	11. N. Hampshi'e.	11. Washington.
12. Georgia.	12. N. Hampshi'e.	12. N. Carolina.	12. Georgia.	12. Oregon.	12. N. Carolina.	12. New Mexico.	12. Michigan.	12. Wyoming.
13. New Mexico.	13. Maine.	13. Georgia.	13. N. Hampshire.	13. N. Carolina.	13. Washington.	13. Alaska.	13. Maine.	13. Alaska.
14. Wyoming.		14. N. Hampshi'e.	14. S. Carolina.		14. Georgia.	14. N. Carolina.		14. N. Carolina.
15. S. Carolina.		15. Michigan.	15. New Mexico.		15. Michigan.	15. Georgia.		15. N. Hampshi'e.
16. N. Hampshire.		16. Wyoming.	16. Virginia.		16. S. Carolina.	16. N. Hampshire.		16. Georgia.
17. Virginia.		17. S. Carolina.	17. Wyoming.		17. Maine.	17. S. Carolina.		17. Michigan.
18. Alaska.		18. Maine.	18. Maine.		18. Virginia.	18. Virginia.		18. Maine.
19. Maine.		19. Virginia.	19. Tennessee.		19. Wyoming.	19. Maine.		19. S. Carolina.
20. Tennessee.		20. Alaska.	20. Alabama.		20. Tennessee.	20. Tennessee.		20. Tennessee.
21. Alabama.		21. Tennessee.	21. Alaska.		21. Alabama.	21. Alabama.		21. Virginia.
		22. Alabama.			22. Alaska.			22. Alabama.

PRODUCTION UNACCOUNTED FOR IN THE PRECEDING TABLES.

In addition to the returns received directly from the mines, there are several minor points to be included in the total yield. A larger item than it is usually considered to be is the annual hoarding of rich specimens. This is not accounted for in the mine production as reported. While it is impossible to state the actual amount thus absorbed with any degree of precision, a careful estimate would place the value of the gold nuggets and ore annually added to the cabinets of collectors at not less than $150,000, and that of the silver ore at about $50,000. This, in view of the great number of mineral collections maintained throughout the mining territory, is certainly not an overestimate.

There is also quite an extensive manufacture of gold quartz into jewelry and souvenirs, particularly in San Francisco. The value so absorbed probably does not fall short of $50,000 annually. In 1870 the United States mining commissioner estimated the amount of gold hoarded as specimens or worked up by local jewelers at $400,000. The same authority, at that period, estimated the annual loss of gold-dust in handling as currency at $100,000. As the practice of using dust for money has almost disappeared, the amount so lost is now very small.

Another indefinite quantity is the value of precious metal lost in melting, in assay grains, etc. Summing up the estimates for these additional items, the following result is reached:

TABLE CLXXIX.—PRODUCTION UNACCOUNTED FOR IN TABULATION.

	Gold.	Silver.	Total.
Bullion product shown in preceding tables	$33,379,663	$41,110,957	$74,490,620
Estimated value of specimens hoarded	150,000	50,000	200,000
Estimated value of gold quartz made into jewelry and souvenirs	50,000		50,000
Estimated value of gold dust lost in handling as currency	10,000		10,000
Estimated loss in melting and assaying, assay grains, etc	20,000	10,000	30,000
Total	33,609,663	41,170,957	74,780,620

ASSAY VALUE OF FINE BULLION.

For convenience in referring to the dual series of troy weights of fine bullion and their equivalent assay values, the following conversion tables, which were prepared for use in tabulating the census statistics of production, are here appended:

TABLE CLXXX.—CONVERSION OF TROY OUNCES

GOLD.

1 ounce Troy = $20.671834. 1 dollar = 0.048374967925 ounce Troy.

	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.
1	1	20.671834	11	227.390174	21	434.108514	31	640.826854	41	847.545194
2	2	41.343668	12	248.062008	22	454.780348	32	661.498688	42	868.217028
3	3	62.015502	13	268.733842	23	475.452182	33	682.170522	43	888.888862
4	4	82.687336	14	289.405676	24	496.124016	34	702.842356	44	909.560696
5	5	103.359170	15	310.077510	25	516.795850	35	723.514190	45	930.232530
6	6	124.031004	16	330.749344	26	537.467684	36	744.186024	46	950.904364
7	7	144.702838	17	351.421178	27	558.139518	37	764.857858	47	971.576198
8	8	165.374672	18	372.093012	28	578.811352	38	785.529692	48	992.248032
9	9	186.046506	19	392.764846	29	599.483186	39	806.201526	49	1,012.919866
10	10	206.718340	20	413.436680	30	620.155020	40	826.873360	50	1,033.591700

	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.
1	100	2,067.1834	1,100	22,739.0174	2,100	43,410.8514	3,100	64,082.6854	4,100	84,754.5194
2	200	4,134.3668	1,200	24,806.2008	2,200	45,478.0348	3,200	66,149.8688	4,200	86,821.7028
3	300	6,201.5502	1,300	26,873.3842	2,300	47,545.2182	3,300	68,217.0522	4,300	88,888.8862
4	400	8,268.7336	1,400	28,940.5676	2,400	49,612.4016	3,400	70,284.2356	4,400	90,956.0696
5	500	10,335.9170	1,500	31,007.7510	2,500	51,679.5850	3,500	72,351.4190	4,500	93,023.2530
6	600	12,403.1004	1,600	33,074.9344	2,600	53,746.7684	3,600	74,418.6024	4,600	95,090.4364
7	700	14,470.2838	1,700	35,142.1178	2,700	55,813.9518	3,700	76,485.7858	4,700	97,157.6198
8	800	16,537.4672	1,800	37,209.3012	2,800	57,881.1352	3,800	78,552.9692	4,800	99,224.8032
9	900	18,604.6506	1,900	39,276.4846	2,900	59,948.3186	3,900	80,620.1526	4,900	101,291.9866
10	1,000	20,671.8340	2,000	41,343.6680	3,000	62,015.5020	4,000	82,687.3360	5,000	103,359.1700

SILVER.

1 ounce Troy = $1.2929. 1 dollar = 0.773455023513 ounce Troy.

	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.
1	1	1.2929	11	14.2219	21	27.1509	31	40.0799	41	53.0089
2	2	2.5858	12	15.5148	22	28.4438	32	41.3728	42	54.3018
3	3	3.8787	13	16.8077	23	29.7367	33	42.6657	43	55.5947
4	4	5.1716	14	18.1006	24	31.0296	34	43.9586	44	56.8876
5	5	6.4645	15	19.3935	25	32.3225	35	45.2515	45	58.1805
6	6	7.7574	16	20.6864	26	33.6154	36	46.5444	46	59.4734
7	7	9.0503	17	21.9793	27	34.9083	37	47.8373	47	60.7663
8	8	10.3432	18	23.2722	28	36.2012	38	49.1302	48	62.0592
9	9	11.6361	19	24.5651	29	37.4941	39	50.4231	49	63.3521
10	10	12.9290	20	25.8580	30	38.7870	40	51.7160	50	64.6450

	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.
1	100	129.29	1,100	1,422.19	2,100	2,715.09	3,100	4,007.99	4,100	5,300.89
2	200	258.58	1,200	1,551.48	2,200	2,844.38	3,200	4,137.28	4,200	5,430.18
3	300	387.87	1,300	1,680.77	2,300	2,973.67	3,300	4,266.57	4,300	5,559.47
4	400	517.16	1,400	1,810.06	2,400	3,102.96	3,400	4,395.86	4,400	5,688.76
5	500	646.45	1,500	1,939.35	2,500	3,232.25	3,500	4,525.15	4,500	5,818.05
6	600	775.74	1,600	2,068.64	2,600	3,361.54	3,600	4,654.44	4,600	5,947.34
7	700	905.03	1,700	2,197.93	2,700	3,490.83	3,700	4,783.73	4,700	6,076.63
8	800	1,034.32	1,800	2,327.22	2,800	3,620.12	3,800	4,913.02	4,800	6,205.92
9	900	1,163.61	1,900	2,456.51	2,900	3,749.41	3,900	5,042.31	4,900	6,335.21
10	1,000	1,292.90	2,000	2,585.80	3,000	3,878.70	4,000	5,171.60	5,000	6,464.50

OF FINE METAL INTO UNITED STATES MONEY.

GOLD.

1 ounce Troy = $20.671834. 1 dollar = 0.048374957925 ounce Troy.

Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	
51	1,054.263534	61	1,260.981874	71	1,467.700214	81	1,674.418554	91	1,881.136894	1
52	1,074.935368	62	1,281.653708	72	1,488.372048	82	1,695.090388	92	1,901.808728	2
53	1,095.607202	63	1,302.325542	73	1,509.043882	83	1,715.762222	93	1,922.480562	3
54	1,116.279036	64	1,322.997376	74	1,529.715716	84	1,736.434056	94	1,943.152396	4
55	1,136.950870	65	1,343.669210	75	1,550.387550	85	1,757.105890	95	1,963.824230	5
56	1,157.622704	66	1,364.341044	76	1,571.059384	86	1,777.777724	96	1,984.496064	6
57	1,178.294538	67	1,385.012878	77	1,591.731218	87	1,798.449558	97	2,005.167898	7
58	1,198.966372	68	1,405.684712	78	1,612.403052	88	1,819.121392	98	2,025.839732	8
59	1,219.638206	69	1,426.356546	79	1,633.074886	89	1,839.793226	99	2,046.511566	9
60	1,240.310040	70	1,447.028380	80	1,653.746720	90	1,860.465060	100	2,067.183400	10

Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	
5,100	105,426.3534	6,100	126,098.1874	7,100	146,770.0214	8,100	167,441.8554	9,100	188,113.6894	1
5,200	107,493.5368	6,200	128,165.3708	7,200	148,837.2048	8,200	169,509.0388	9,200	190,180.8728	2
5,300	109,560.7202	6,300	130,232.5542	7,300	150,904.3882	8,300	171,576.2222	9,300	192,248.0562	3
5,400	111,627.9036	6,400	132,299.7376	7,400	152,971.5716	8,400	173,643.4056	9,400	194,315.2396	4
5,500	113,695.0870	6,500	134,366.9210	7,500	155,038.7550	8,500	175,710.5890	9,500	196,382.4230	5
5,600	115,762.2704	6,600	136,434.1044	7,600	157,105.9384	8,600	177,777.7724	9,600	198,449.6064	6
5,700	117,829.4538	6,700	138,501.2878	7,700	159,173.1218	8,700	179,844.9558	9,700	200,516.7898	7
5,800	119,896.6372	6,800	140,568.4712	7,800	161,240.3052	8,800	181,912.1392	9,800	202,583.9732	8
5,900	121,963.8206	6,900	142,635.6546	7,900	163,307.4886	8,900	183,979.3226	9,900	204,651.1566	9
6,000	124,031.0040	7,000	144,702.8380	8,000	165,374.6720	9,000	186,046.5060	10,000	206,718.3400	10

SILVER.

1 ounce Troy = $1.2929. 1 dollar = 0.7734553023513 ounce Troy.

Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	
51	65.9379	61	78.8669	71	91.7959	81	104.7249	91	117.6539	1
52	67.2308	62	80.1598	72	93.0888	82	106.0178	92	118.9468	2
53	68.5237	63	81.4527	73	94.3817	83	107.3107	93	120.2397	3
54	69.8166	64	82.7456	74	95.6746	84	108.6036	94	121.5326	4
55	71.1095	65	84.0385	75	96.9675	85	109.8965	95	122.8255	5
56	72.4024	66	85.3314	76	98.2604	86	111.1894	96	124.1184	6
57	73.6953	67	86.6243	77	99.5533	87	112.4823	97	125.4113	7
58	74.9882	68	87.9172	78	100.8462	88	113.7752	98	126.7042	8
59	76.2811	69	89.2101	79	102.1391	89	115.0681	99	127.9971	9
60	77.5740	70	90.5030	80	103.4320	90	116.3610	100	129.2900	10

Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	
5,100	6,593.79	6,100	7,886.69	7,100	9,179.59	8,100	10,472.49	9,100	11,765.39	1
5,200	6,723.08	6,200	8,015.98	7,200	9,308.88	8,200	10,601.78	9,200	11,894.68	2
5,300	6,852.37	6,300	8,145.27	7,300	9,438.17	8,300	10,731.07	9,300	12,023.97	3
5,400	6,981.66	6,400	8,274.56	7,400	9,567.46	8,400	10,860.36	9,400	12,153.26	4
5,500	7,110.95	6,500	8,403.85	7,500	9,696.75	8,500	10,989.65	9,500	12,282.55	5
5,600	7,240.24	6,600	8,533.14	7,600	9,826.04	8,600	11,118.94	9,600	12,411.84	6
5,700	7,369.53	6,700	8,662.43	7,700	9,955.33	8,700	11,248.23	9,700	12,541.13	7
5,800	7,498.82	6,800	8,791.72	7,800	10,084.62	8,800	11,377.52	9,800	12,670.42	8
5,900	7,628.11	6,900	8,921.01	7,900	10,213.91	8,900	11,506.81	9,900	12,799.71	9
6,000	7,757.40	7,000	9,050.30	8,000	10,343.20	9,000	11,636.10	10,000	12,929.00	10

TABLE CLXXXI.—CONVERSION OF UNITED STATES

GOLD.

1 dollar = 0.048374367925 ounce Troy. 1 ounce Troy = $20.671834.

	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.
1	1	0.048375	11	0.532125	21	1.015874	31	1.499624	41	1.983373
2	2	0.096750	12	0.580499	22	1.064249	32	1.547999	42	2.031748
3	3	0.145125	13	0.628874	23	1.112624	33	1.596374	43	2.080123
4	4	0.193500	14	0.677249	24	1.160999	34	1.644749	44	2.128498
5	5	0.241875	15	0.725624	25	1.209374	35	1.693124	45	2.176873
6	6	0.290250	16	0.773999	26	1.257749	36	1.741498	46	2.225248
7	7	0.338625	17	0.822374	27	1.306124	37	1.789873	47	2.273623
8	8	0.387000	18	0.870749	28	1.354499	38	1.838248	48	2.321998
9	9	0.435375	19	0.919124	29	1.402874	39	1.886623	49	2.370373
10	10	0.483750	20	0.967499	30	1.451249	40	1.934998	50	2.418748

	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.
1	100	4.837496	1,100	53.212454	2,100	101.587412	3,100	149.962370	4,100	198.337327
2	200	9.674992	1,200	58.049950	2,200	106.424907	3,200	154.799865	4,200	203.174823
3	300	14.512487	1,300	62.887445	2,300	111.262403	3,300	159.637361	4,300	208.012319
4	400	19.349983	1,400	67.724941	2,400	116.099899	3,400	164.474857	4,400	212.849815
5	500	24.187479	1,500	72.562437	2,500	120.937395	3,500	169.312353	4,500	217.687311
6	600	29.024975	1,600	77.399933	2,600	125.774891	3,600	174.149849	4,600	222.524806
7	700	33.862471	1,700	82.237428	2,700	130.612386	3,700	178.987344	4,700	227.362302
8	800	38.699966	1,800	87.074924	2,800	135.449882	3,800	183.824840	4,800	232.199798
9	900	43.537462	1,900	91.912420	2,900	140.287378	3,900	188.662336	4,900	237.037294
10	1,000	48.374958	2,000	96.749916	3,000	145.124874	4,000	193.499832	5,000	241.874790

SILVER.

1 dollar = 0.773455023513 Troy ounce. 1 ounce Troy = $1.2929.

	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.
1	1	0.77346	11	8.50801	21	16.24256	31	23.97711	41	31.71166
2	2	1.54691	12	9.28146	22	17.01601	32	24.75056	42	32.48511
3	3	2.32037	13	10.05492	23	17.78947	33	25.52402	43	33.25857
4	4	3.09382	14	10.82837	24	18.56292	34	26.29747	44	34.03202
5	5	3.86728	15	11.60183	25	19.33638	35	27.07093	45	34.80548
6	6	4.64073	16	12.37528	26	20.10983	36	27.84438	46	35.57893
7	7	5.41419	17	13.14874	27	20.88329	37	28.61784	47	36.35239
8	8	6.18764	18	13.92219	28	21.65674	38	29.39129	48	37.12584
9	9	6.96110	19	14.69565	29	22.43020	39	30.16475	49	37.89930
10	10	7.73455	20	15.46910	30	23.20365	40	30.93820	50	38.67275

	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.
1	100	77.34550	1,100	850.80053	2,100	1,624.25555	3,100	2,397.71057	4,100	3,171.16560
2	200	154.69100	1,200	928.14603	2,200	1,701.60105	3,200	2,475.05608	4,200	3,248.51110
3	300	232.03651	1,300	1,005.49153	2,300	1,778.94655	3,300	2,552.40158	4,300	3,325.85660
4	400	309.38201	1,400	1,082.83703	2,400	1,856.29206	3,400	2,629.74708	4,400	3,403.20210
5	500	386.72751	1,500	1,160.18254	2,500	1,933.63756	3,500	2,707.09258	4,500	3,480.54761
6	600	464.07301	1,600	1,237.52804	2,600	2,010.98306	3,600	2,784.43808	4,600	3,557.89311
7	700	541.41852	1,700	1,314.87354	2,700	2,088.32856	3,700	2,861.78359	4,700	3,635.23861
8	800	618.76402	1,800	1,392.21904	2,800	2,165.67407	3,800	2,939.12909	4,800	3,712.58411
9	900	696.10952	1,900	1,469.56454	2,900	2,243.01957	3,900	3,016.47459	4,900	3,789.92962
10	1,000	773.45502	2,000	1,546.91005	3,000	2,320.36507	4,000	3,093.82009	5,000	3,867.27512

MONEY INTO TROY OUNCES OF FINE METAL.

GOLD.

1 dollar = 0.048374937025 ounce Troy. 1 ounce Troy = $20.671834.

Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	
51	2.467123	61	2.950872	71	3.434622	81	3.918373	91	4.402121	1
52	2.515498	62	2.999247	72	3.482997	82	3.966747	92	4.450496	2
53	2.563873	63	3.047622	73	3.531373	83	4.015122	93	4.498871	3
54	2.612248	64	3.095997	74	3.579747	84	4.063496	94	4.547246	4
55	2.660623	65	3.144372	75	3.628123	85	4.111871	95	4.595621	5
56	2.708998	66	3.192747	76	3.676497	86	4.160246	96	4.643996	6
57	2.757373	67	3.241123	77	3.724872	87	4.208621	97	4.692371	7
58	2.805748	68	3.289497	78	3.773247	88	4.256996	98	4.740746	8
59	2.854123	69	3.337872	79	3.821622	89	4.305371	99	4.789121	9
60	2.902497	70	3.386247	80	3.869997	90	4.353746	100	4.837496	10

Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	
5,100	246.712285	6,100	295.087248	7,100	343.462201	8,100	391.837159	9,100	440.212117	1
5,200	251.549781	6,200	299.924739	7,200	348.299697	8,200	396.674655	9,200	445.049613	2
5,300	256.387277	6,300	304.762235	7,300	353.137193	8,300	401.512151	9,300	449.887109	3
5,400	261.224773	6,400	309.599731	7,400	357.974689	8,400	406.349647	9,400	454.724604	4
5,500	266.062269	6,500	314.437227	7,500	362.812184	8,500	411.187142	9,500	459.562100	5
5,600	270.899764	6,600	319.274722	7,600	367.649680	8,600	416.024638	9,600	464.399596	6
5,700	275.737260	6,700	324.112218	7,700	372.487176	8,700	420.862134	9,700	469.237092	7
5,800	280.574756	6,800	328.949714	7,800	377.324672	8,800	425.699630	9,800	474.074588	8
5,900	285.412252	6,900	333.787210	7,900	382.162168	8,900	430.537126	9,900	478.912083	9
6,000	290.249748	7,000	338.624705	8,000	387.999663	9,000	435.374621	10,000	483.749579	10

SILVER.

1 dollar = 0.773455623513 Troy ounce. 1 ounce Troy = $1.2929.

Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	
51	39.44621	61	47.18076	71	54.91531	81	62.64986	91	70.38441	1
52	40.21966	62	47.95421	72	55.68876	82	63.42331	92	71.15786	2
53	40.99312	63	48.72767	73	56.46222	83	64.19677	93	71.93132	3
54	41.76657	64	49.50113	74	57.23567	84	64.97022	94	72.70477	4
55	42.54003	65	50.27458	75	58.00913	85	65.74368	95	73.47823	5
56	43.31348	66	51.04803	76	58.78258	86	66.51713	96	74.25168	6
57	44.08694	67	51.82149	77	59.55604	87	67.29059	97	75.02514	7
58	44.86039	68	52.59494	78	60.32949	88	68.06404	98	75.79859	8
59	45.63385	69	53.36840	79	61.10295	89	68.83750	99	76.57205	9
60	46.40730	70	54.14185	80	61.87640	90	69.61095	100	77.34550	10

Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	
5,100	3,944.63062	6,100	4,718.07564	7,100	5,491.52067	8,100	6,264.96569	9,100	7,038.44071	1
5,200	4,021.96612	6,200	4,795.42115	7,200	5,568.87617	8,200	6,343.33119	9,200	7,115.78622	2
5,300	4,099.31162	6,300	4,872.76665	7,300	5,646.22167	8,300	6,419.67670	9,300	7,193.13172	3
5,400	4,176.65713	6,400	4,950.11215	7,400	5,723.56717	8,400	6,497.02220	9,400	7,270.47722	4
5,500	4,254.00263	6,500	5,027.45765	7,500	5,800.91268	8,500	6,574.36770	9,500	7,347.82272	5
5,600	4,331.34813	6,600	5,104.80316	7,600	5,878.25818	8,600	6,651.71320	9,600	7,425.16823	6
5,700	4,408.69363	6,700	5,182.14866	7,700	5,955.60368	8,700	6,729.05870	9,700	7,502.51373	7
5,800	4,486.03914	6,800	5,259.49416	7,800	6,032.94918	8,800	6,806.40421	9,800	7,579.85923	8
5,900	4,563.38464	6,900	5,336.83966	7,900	6,110.29469	8,900	6,883.74971	9,900	7,657.20473	9
6,000	4,640.73014	7,000	5,414.18516	8,000	6,187.64019	9,000	6,961.09521	10,000	7,734.55024	10

DISCOUNT AND MARKET VALUE.

The figures given in the preceding tables are of assay values, and are therefore considerably higher than the actual market value. Disregarding express charges, commissions, and cost of refining and coining, there is still a large deduction to be made for this discount, in estimating the cash value of the bullion to the producers. Assuming the gold to have brought on the average $20 per troy ounce and the silver $1 12½ per troy ounce, the cash received would have been $32,394,794 for the gold, $35,772,160 for the silver, and $68,166,954 total. The loss to the miners, as compared with the full assay value, would therefore have been $984,869 on the gold, $5,338,797 on the silver, and $6,323,666 altogether, or about one thirty-fourth of the full gold coining value, over one-eighth of the nominal silver value, and over one-twelfth in all, during the single census year. While there is no regular discount on gold, the large amount of placer gold sold at an undervaluation renders the average price assumed a probable one. The price for the silver is an estimate of average local rates for the year.

THE OUTLOOK.

The immediate outlook for the precious-metal mines, as a whole, is very encouraging. The great Leadville (Colorado), Eureka (Nevada), Tombstone (Arizona), and Bodie (California) districts are maintaining a steady output, while the new Wood River and other districts in Idaho, and a number of recent discoveries in Arizona, hold forth great promise for the future. In fact, estimates of the yield subsequent to the census period indicate an actual and considerable gain.(*a*)

TRANSPORTATION OF BULLION.

INTERNAL MOVEMENT.—The internal movement of the precious metals is to a certain extent indicated by the returns of the express companies. Notwithstanding the sources of error inherent in these transportation statistics when adopted as the sole basis for an estimate of the mine output, which have already been commented upon, the express figures in many cases serve as a means of supplying deficiencies in the census schedule data, and are always useful as a check upon information collected directly from the mines.

The operations of Wells, Fargo & Co.'s Express during the census year, and for the months corresponding at the beginning and at the close of that period, are shown in the accompanying table:

TABLE CLXXXII.—SHIPMENTS OF BULLION, DUST, AND AMALGAM THROUGH WELLS, FARGO & CO.'S EXPRESS.

ARIZONA.

Office.	Shipments during census year.			Shipments in June, 1879.			Shipments in June, 1880.		
	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.
Casa Grande	.....	$385	$385	.....	.....	.....	.....	.....	.....
Contention City	.....	122,900	122,900	.....	.....	.....	.....	$76,960	$76,960
Florence	.....	177,568	177,568	.....	$11,604	$11,604	.....	.....	.....
Globe	.....	.....	.....	.....	.....	.....	.....	4,631	4,631
Maricopa	$160	301,273	301,433	.....	25,031	25,031	.....	.....	.....
Millville	.....	78,153	78,153	.....	.....	.....	.....	77,868	77,868
Phœnix	56,475	113,495	169,970	$800	19,355	19,955	$1,421	750	2,171
Prescott	31,750	116,937	148,687	5,050	1,819	6,869	4,980	2,141	7,121
Tombstone	.....	300	300	.....	.....	.....	.....	.....	.....
Tucson	60,529	469,140	529,669	10,661	3,129	13,790	3,420	11,711	15,131
Wickenburg	36,138	8,842	44,980	400	1,558	1,958	420	325	745
Yuma	39,416	13,707	53,123	1,090	.....	1,090	1,700	.....	1,700
Total	224,468	1,402,700	1,627,168	17,801	61,896	79,697	11,941	174,386	186,327

CALIFORNIA.

Alleghany	$31,726	.....	$31,726	$4,676	.....	$4,676	$2,917	.....	$2,917
Alta	450	.....	450	.....	.....	.....	.....	.....	.....
Alvarado	.....	.....	.....	.....	.....	.....	.....	.....	.....
Amador	634,720	.....	634,720	73,400	.....	73,400	44,001	.....	44,001
Anderson	11,420	.....	11,420	705	.....	705	900	.....	900
Angel's Camp	54,759	.....	54,759	1,520	.....	1,520	5,964	.....	5,964
Arcata	58,731	.....	58,731	4,150	.....	4,150	1,461	.....	1,461
Auburn	171,930	.....	171,930	12,920	.....	12,920	20,180	.....	20,180
Bakersfield	13,166	.....	13,166	1,105	.....	1,105	1,955	.....	1,955
Bear Valley	14,954	.....	14,954	422	.....	422	2,000	.....	2,000
Benton	.....	$137,876	137,876	.....	$17,758	17,758	.....	.....	.....
Berendo	2,625	.....	2,625	437	.....	437	332	.....	332
Biggs	1,500	.....	1,500	.....	.....	.....	.....	.....	.....
Big Oak Flat	20,545	930	21,475	3,040	.....	3,040	3,800	.....	3,800
Bishop Creek	214	50	264	.....	.....	.....	.....	.....	.....

a While this report was going through the press, Wells, Fargo & Co. reported the yield of the mines of the western states and territories, together with that from British Columbia, to have been $31,869,686 gold, $45,077,829 silver, and $76,947,515 total, for the calendar year 1881.

TABLE CLXXXII.—SHIPMENTS OF BULLION, DUST, AND AMALGAM, ETC.—Continued.

CALIFORNIA—Continued.

Office.	Shipments during census year.			Shipments in June, 1879.			Shipments in June, 1880.		
	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.
Blue Cañon	$3,421		$3,421	$1,150		$1,150	$2,150		$2,150
Bodie	2,708,038	$375	2,708,413	143,933	$375	144,308	298,550		298,550
Borden	18,767		18,767	1,635		1,635	700		700
Brownsville	17,840		17,840	1,275		1,275	5,989		5,989
Caliente	2,965		2,965	60		60	3,745		3,745
Callahan's Ranch	71,371		71,371	5,155		5,155	3,137		3,137
Camanche	49,605		49,605	6,000		6,000	2,900		2,900
Campo Seco	13,970		13,970	535		535	1,040		1,040
Camptonville	204,165		204,165	28,850		28,850	40,500		40,500
Centreville	165		165	100		100			
Chico	86,009		86,009	8,565		8,565	6,585		6,585
Chinese Camp	37,520		37,520	2,560		2,560	3,968		3,968
Chualar	122		122						
Clipper Mills	9,125		9,125	512		512	1,125		1,125
Colfax	67,928		67,928	9,550		9,550	9,425		9,425
Columbia	107,125		107,125	14,020		14,020	13,550		13,550
Columbus	38,579		38,579	5,980		5,980	2,255		2,255
Copper City	200	111,949	112,149	200	13,517	13,717			
Copperopolis	1,688		1,688	413		413	150		150
Cottonwood	46,639		46,639	2,680		2,680	2,100		2,100
Coulterville	42,412		42,412	6,055		6,055	12,570		12,570
Crescent City	14,315		14,315	2,025		2,025	20		20
Crescent Mills	23,607		23,607	1,980		1,980	8,176		8,176
Darwin	6,105	41,004	47,109	2,534	10,300	12,834	106	$9,750	9,856
Delano	75		75						
Diamond Spring	5,202		5,202	866		866			
Downieville	55,694		55,694	5,443		5,443	570		570
Drytown	57,564		57,564	5,530		5,530	9,096		9,096
Dutch Flat	305,045		305,045	32,475		32,475	32,650		32,650
El Dorado	73,921		73,921	13,820		13,820	5,787		5,787
Emigrant Gap	5,777		5,777	75		75			
Etna Mills	238,056		238,056	23,395		23,395	22,080		22,080
Eureka	62,902	100	63,002	5,690		5,690	1,350		1,350
Eureka Mills	539,870		539,870	46,000		46,000	41,500		41,500
Farmington	110		110						
Firebaugh	130		130						
Folsom City	345,265		345,265	32,950		32,950	29,760		29,760
Forbestown	30,127		30,127	6,713		6,713	2,439		2,439
Forest City	205,675		205,675	13,900		13,900	33,500		33,500
Forest Hill	134,937		134,937	13,046		13,046	18,150		18,150
Fort Jones	204,187		204,187	22,189		22,189	8,397		8,397
French Corral	400,916		400,916	50,595		50,595	24,140		24,140
French Gulch	52,402		52,402	9,049		9,049	5,599		5,599
Fresno	20,969		20,969	432		432	1,632		1,632
Georgetown	85,200		85,200	12,700		12,700	10,860		10,860
Gibsonville	88,143		88,143	3,200		3,200	7,900		7,900
Gold Run	53,111		53,111	11,483		11,483	2,760		2,760
Grass Valley	780,795		780,795	87,250		87,250	91,200		91,200
Grayson	22		22						
Greenville	43,617		43,617	2,885		2,885	5,410		5,410
Guadaloupe	112		112						
Havilah	36,415		36,415	6,308		6,308	745		745
Hornitos	121,829		121,829	12,500		12,500	18,453		18,453
Howland's	112,623		112,623	4,393		4,393	10,115		10,115
Independence	9,840	7,000	16,840	400		400	300		300
Ione	79,365		79,365	9,095		9,095	9,825		9,825
Iowa Hill	108,775		108,775	16,800		16,800	8,275		8,275
Jackson	334,056		334,056	43,423		43,423	36,160		36,160
Jamestown	78,393		78,393	9,350		9,350	5,427		5,427
Jamison	14,077		14,077	1,250		1,250	670		670
Jolon	260		260						
Kernville	99,615		99,615	11,625		11,625	4,005	75	4,080
Knight's Ferry	11,188	150	11,338	1,736		1,736	1,355		1,355
La Grange	77,304		77,304	7,500		7,500	300		300
La Porte	258,316		258,316	19,690		19,690	9,710		9,710
Latrobe	45,903		45,903	2,220		2,220	3,770		3,770
Lewiston	10,765		10,765	2,872		2,872	4,748		4,748
Lincoln	26,635		26,635	1,825		1,825	3,250		3,250
Lompoc	300		300	50		50			
Lone Pine	6,114	2,545	8,659	150	200	350	405	124	529
Los Angeles	14,020	56,897	70,917	2,555	1,500	4,055	2,330	7,463	9,793
Madera	5,964		5,964	284		284	248		248
Mammoth	33,613	50	33,663	9,488		9,488			
Mariposa	67,606		67,606	5,533		5,533	4,530		4,530
Martinez	4,815		4,815						
Marysville	482,266		482,266	65,678		65,678	7,913		7,913
Merced	8,363		8,363	800		800	76		76
Michigan Bar	47,139		47,139	2,565		2,565	2,435		2,435
Michigan Bluffs	93,505		93,505	9,375		9,375	4,525		4,525
Millville	400		400						

TABLE CLXXXII.—SHIPMENTS OF BULLION, DUST, AND AMALGAM, ETC.—Continued.

CALIFORNIA—Continued.

Office.	Shipments during census year.			Shipments in June, 1879.			Shipments in June, 1880.		
	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.
Milton	$16,704		$16,704	$3,110		$3,110	$2,332		$2,332
Modesto	5		5						
Mohave	220	$26,200	26,420				150		150
Mokelumne Hill	205,331		205,331	21,857		21,857	21,016		21,016
Murphy's	34,323		34,323	4,160		4,160	4,675		4,675
Nevada City	1,249,017	3,850	1,251,867	137,064	$1,160	138,224	105,000		105,000
Newcastle	54,712		54,712	6,550		6,550	2,292		2,292
Newhall	7,150		7,150	400		400	2,172		2,172
North San Juan	560,838		560,838	23,005		23,005	49,045		49,045
Oleta	48,746		48,746	6,479		6,479	6,912		6,912
Oroville	818,715		818,715	102,515		102,515	28,115		28,115
Pino	8,524		8,524	1,295		1,295	363		363
Placerville	300,397	40	300,437	32,039		32,039	41,816		41,816
Plainsburg	854		854						
Plymouth	262,593		262,593	2,172		2,172	42,050		42,050
Porterville	1,695		1,695	200		200	60		60
Quincy	48,677		48,677	5,469		5,469	3,976		3,976
Ravenna	1,089		1,089				135		135
Redding	148,214		148,214	16,590		16,590	18,734		18,734
Red Bluff	2,303		2,303	240		240			
Riverside	50		50						
Rocklin	744	125	869				197		197
Roseville	1,500		1,500						
Rough and Ready	15,114		15,114	430		430	1,150		1,150
Sacramento City	118,032		118,032	17,765		17,765	4,965		4,965
Saint Louis	4,900		4,900				4,200		4,200
Salinas	16		16						
San Andreas	154,398		154,398	20,020		20,020	11,800		11,800
San Antonio	50		50						
San Bernardino	6,213	125,943	131,154	150	5,257	5,407	230	$11,633	11,863
San Buenaventura	221		221						
San Diego	46,710		46,710	2,825		2,825	4,200		4,200
Sanel	205		205				500		500
San José	6,900		6,900	3,050		3,050			
San Luis Obispo	3,002		3,002						
Santa Cruz	58		58	58		58			
Shasta	181,634		181,634	29,760		29,760	23,893		23,893
Sheep Ranch	52,454		52,454				3,100		3,100
Shingle Springs	44,967		44,967	3,807		3,807	7,433		7,433
Sierra City	352,700		352,700	31,150		31,150	24,500		24,500
Sierraville	180		180						
Smartsville	201,070		201,070	1,280		1,280	25,960		25,960
Snelling	5,963		5,963	225		225	465		465
Soledad	225		225				100		100
Sonora	419,501		419,501	19,850		19,850	20,331		20,331
Spadra							421		421
Spaniah Ranch	83,719	17,143	100,862	17,361		17,361	9,966		9,966
Sumner	1,225		1,225	500		500			
Sutter Creek	165,269		165,269	20,750		20,750	21,490		21,490
Sweetland	26,140		26,140	10,000		10,000	4,000		4,000
Tehichipa	2,632		2,632	516		516	887		887
Todd's Valley	26,864		26,864	8,690		8,690	1,225		1,225
Trinity Centre	14,147		14,147	919		919	900		900
Truckee	262		262						
Tulare	450		450						
Vallecita	10,838		10,838	1,675		1,675	417		417
Visalia	2,650	60	2,710	275		275			
Watsonville	332		332	85		85			
Weaverville	459,463		459,463	37,810		37,810	43,915		43,915
West Oakland							1,000		1,000
Wheatland	1,030		1,030	260		260			
Williams	1,375		1,375						
Yreka	81,180		81,180	8,155		8,155	4,650		4,650
Total	16,829,915	532,286	17,362,201	1,604,716	50,067	1,654,783	1,547,651	29,045	1,576,696

TABLE CLXXXII.—SHIPMENTS OF BULLION, DUST, AND AMALGAM, ETC.—Continued.

IDAHO.

Office.	Shipments during census year.			Shipments in June, 1879.			Shipments in June, 1880.		
	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.
Albion	$3,145		$3,145				$434		$434
Boisé City	140,850	$96,546	237,405	$8,550	$12,948	$21,478	9,635	$110	9,735
Centreville	43,215	7,873	51,088	4,070		4,070	338		338
Idaho City	438,612	103,530	542,142	44,289		44,289	25,453		25,453
Lewiston	183,125		183,125	13,463		13,463	137		137
Moscow	794		794						
Placerville	115,833		115,833	25,860		25,860	4,170		4,170
Quartzburg	150,500		150,500	4,520		4,520	18,200		18,200
Rocky Bar (a)	17,309	83,712	101,021				1,508	5,600	7,108
Silver City	18,510	340,043	358,553	2,450	11,795	14,245	1,916	11,110	13,026
Total	1,120,902	631,704	1,752,606	103,182	24,743	127,925	62,071	16,820	78,891

NEVADA.

Aurora	$2,125		$2,125	$150		$150			
Austin		$903,375	903,375		$95,788	95,788		$130,791	$130,791
Battle Mountain	10	6,395	6,405						
Belleville		962,102	962,102		48,757	48,757		108,044	108,044
Belmont		41,009	41,009					281	281
Beowawe		123,992	123,992		21,030	21,030			
Cambridge	250		250				$450		450
Carson City		28,516	28,516		1,600	1,600		2,222	2,222
Cherry Creek	500	233,609	234,109		21,933	21,933		22,000	22,000
Columbus		24,960	24,960		20,792	20,792			
Cornucopia	25	51,814	51,839						
Dayton		86,962	86,962		22,370	22,370			
Elko	12,597	9,776	22,373	1,142		1,142			
Eureka		1,643,254	1,643,254		153,389	153,389		113,686	113,686
Franktown							25		25
Gold Hill	28,340	22,974	51,314	3,375	10,650	14,025			
Grantsville		381,365	381,365		41,340	41,340		28,203	28,203
Hamilton		53,921	53,921		17,178	17,178			
Humboldt							1,500		1,500
Lewis		139,016	139,016		15,000	15,000		7,000	7,000
Lovelocks	426		426	61		61			
Marietta		58,300	58,300						
Mill City	32,310	1,625	33,935	3,000	1,500	3,500			
Oreana	7,616	2	7,618	1,405		1,405			
Paradise	100	134,536	134,636		4,329	4,329		16,100	16,100
Pioche		287,120	287,120		39,323	39,323		6,950	6,950
Reno	10,080	47,620	57,700				484		484
Rye Patch	4,123	23,300	27,423		17,301	17,301	777	9,065	9,842
Silver City	29,034	33,092	62,126	5,430		5,430	1,480		1,480
Sedan		81,987	81,987						
Silver Peak	17,124	33,482	50,606						
Tuscarora	4,926	1,112,615	1,117,541	1,900	87,805	89,605	1,695	35,151	36,846
Tybo		213,656	213,656		14,800	14,800		13,550	13,550
Unionville	5,471	178,478	183,949	232	15,700	15,932	287	13,200	13,487
Virginia City		6,835,712	6,835,712		652,715	652,715	1,500	297,980	299,380
Wadsworth		701	701		701	701			
Ward	10,460	281,776	292,236	2,100	51,341	53,441	700	150	850
Winnemucca	2,579	5,722	8,301		1,188	1,188			
Total	167,896	14,112,084	14,280,980	17,895	1,356,530	1,374,225	8,858	901,932	910,790

OREGON.

Albany	$473		$473						
Ashland	630		630	$630		$630			
Aurora	150		150						
Astoria	175		175						
Baker City	355,995	$1,110	357,105	31,000		31,000	$18,565		$18,565
Canonville	5,576		5,576	320		320	985		985
Cottage Grove	120		120				25		25
Corvallis							400		400
Dalles	35,065		35,065	175		175			
Empire City	1,316		1,316						
Hepner	190		190						
Hillsborough		155	155						
Jacksonville	148,224		148,224	19,552		19,552	24,890		24,890
La Grande	2,025	25	2,050						
Oakland	480		480						

(a) Through W. C. Tatro's Express.

TABLE CLXXXII.—SHIPMENTS OF BULLION, DUST, AND AMALGAM, ETC.—Continued.

OREGON.—Continued.

Office.	Shipments during census year.			Shipments in June, 1879.			Shipments in June, 1880.		
	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.
Pendleton	$23,912	$0 75	$23,987	$1,400		$1,400			
Portland	274,176	3,145	277,321	20,092		20,092	$11,449		$11,449
Roseburg	6,468		6,468	2,342		2,342	1,837		1,837
Umatilla	26,514		26,514	2,301		2,301	1,347		1,347
Union	40,892		40,892	200		200	361		361
Total	922,381	4,510	926,891	78,002		78,002	59,799		59,799

UTAH.

Corinne	$244		$244	$75		$75			
Kelton	5,062		5,062	350		350	$175		$175
Leeds		$1,003,633	1,003,633		$102,920	102,920		$113,013	113,013
Ogden	767,956	1,233,444	2,001,400	38,797	162,611	201,408	72,527	59,812	132,339
Total	773,262	2,237,077	3,010,339	39,222	265,531	304,753	72,702	172,825	245,527

WASHINGTON.

Colfax	$10,165		$10,165				$1,205		$1,205
Dayton	263		263	$60		$60			
Goldendale	294		294						
Pomeroy	1,103		1,103						
Port Gamble	50		50						
Seattle	752		752						
Tecoma	225		225						
Waitsburg	1,277		1,277	585		585	362		362
Walla Walla	60,809		60,809	6,371		6,371	5,050		5,050
Wallula	200		200						
Total	75,138		75,138	7,016		7,016	6,617		6,617

NEW YORK.

New York		$945,355	$945,355		$146,127	$146,127			
Total		945,355	945,355		146,127	146,127			

MESSENGERS.

Messengers	$94,807	$66,712	$161,519				$1,382	$8,575	$9,957
Total	94,807	66,712	161,519				1,382	8,575	9,957

MEXICO.

Guaymas	$83,110	$100,263	$183,373	$10,499	$15,200	$25,699	$12,601	$23,200	$35,801
La Paz	10,870	543,696	554,566	1,500	46,320	47,820		41,100	41,100
Mazatlan	11,263	614,560	625,823	3,883	78,530	82,413		28,407	28,407
Total	105,243	1,258,519	1,363,762	15,882	140,050	155,932	12,601	92,707	105,308

BRITISH COLUMBIA.

Victoria	$929,260		$929,260	$39,750		$39,750	$37,632		$37,632
Total	929,260		929,260	39,750		39,750	37,632		37,632

TABLE CLXXXIII.—RECAPITULATION OF SHIPMENTS OF BULLION, DUST, AND AMALGAM THROUGH WELLS, FARGO & CO.'S EXPRESS.

UNITED STATES.

State or territory.	Shipments during census year.			Shipments in June, 1879.			Shipments in June, 1880.		
	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.
Arizona	$224,468	$1,402,700	$1,627,168	$17,801	$61,896	$79,697	$11,941	$174,386	$186,327
California	16,829,915	532,286	17,362,201	1,604,716	50,067	1,654,783	1,547,651	29,045	1,576,696
Idaho	1,120,902	631,704	1,752,606	103,182	24,743	127,925	62,071	16,820	78,891
Nevada	167,896	14,113,084	14,280,980	17,695	1,356,530	1,374,225	8,858	901,862	910,720
Oregon	922,381	4,510	926,891	78,002	.....	78,002	59,799	.....	59,799
Utah	773,262	2,237,077	3,010,339	39,222	265,531	304,753	72,702	172,825	245,527
Washington	75,138	.....	75,138	7,016	.....	7,016	6,617	.....	6,617
Total	20,113,962	18,921,361	39,035,323	1,867,634	1,758,767	3,626,401	1,769,639	1,294,038	3,064,577
Messengers	94,807	66,712	161,519	.....	.....	.....	1,382	8,575	9,957
Total	20,208,769	18,988,073	39,196,842	1,867,634	1,758,767	3,626,401	1,771,021	1,303,513	3,074,534
New York	.....	945,355	945,355	.....	146,127	146,127	.....	.....	.....
Total	20,208,769	19,933,428	40,142,197	1,867,634	1,904,894	3,772,528	1,771,021	1,303,513	3,074,534

FOREIGN.

British Columbia	$929,260	.....	$929,260	$39,750	.....	$39,750	$37,632	.....	$37,632
Mexico	105,243	$1,258,519	1,363,762	15,882	$140,050	155,932	12,601	$92,707	105,308
Total	1,034,503	1,258,519	2,293,022	55,632	140,050	195,682	50,233	92,707	142,940
Total United States	20,208,769	19,933,428	40,142,197	1,867,634	1,904,894	3,772,528	1,771,021	1,303,513	3,074,534
Grand total	21,243,272	21,191,947	42,435,219	1,923,266	2,044,944	3,968,210	1,821,254	1,396,220	3,217,474

A statement of the bullion shipments during the census year from offices of Wells, Fargo & Co., at points in the neighborhood of the Comstock lode is annexed, and is followed by a comparison between the outflow in June, 1879, and that in June, 1880:

TABLE CLXXXIV.—BULLION SHIPMENTS FROM POINTS IN NEIGHBORHOOD OF COMSTOCK LODE, THROUGH WELLS, FARGO & CO.'S EXPRESS, FOR THE YEAR ENDING MAY 31, 1880.

County.	Office.	Shipments during census year.			Shipments in June, 1879.			Shipments in June, 1880.		
		Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.
Lyon	Dayton	.....	$86,962	$86,962	.....	$22,370	$22,370	.....	.....	.....
Do	Silver City	$29,034	33,092	62,126	$5,430	.....	5,430	$1,480	.....	$1,480
Ormsby	Carson	.....	28,516	28,516	.....	1,000	1,000	.....	$2,322	2,322
Storey	Gold Hill	28,340	22,974	51,314	3,375	10,650	14,025	.....	.....	.....
Do	Virginia City	.....	6,835,712	6,835,712	.....	652,715	652,715	1,500	397,860	399,360
Washoe	Reno	10,080	47,020	57,700	.....	.....	.....	464	.....	464
	Total	67,454	7,054,876	7,122,330	8,805	687,335	696,140	3,444	400,182	403,626

Comparison between bullion shipments in June, 1879, and June, 1880.

	Gold bullion, dust, and amalgam.	Silver bullion and amalgam.	Total.
Shipments in June, 1879	$8,805	$687,335	$696,140
Shipments in June, 1880	3,444	400,182	403,626
Decrease in June, 1880, from June, 1879	5,361	287,153	292,514

The bullion movement from Utah is partially shown in the following abstract from the returns of the Pacific Express Company:

TABLE CLXXXV.—BULLION SHIPMENTS FROM UTAH, THROUGH PACIFIC EXPRESS COMPANY, DURING YEAR ENDING JUNE 30, 1880.

From—	During six months ending December 31, 1879.			Shipped to—								
				New York.			Omaha.			San Francisco.		
	Gold.	Silver.	Total.	Gold.	Silver.	Total.	Gold.	Silver.	Total.	Gold.	Silver.	Total.
Bingham	$107,500	$7,200	$114,700	.....	$7,200	$7,200	.....	.....	.....	$107,500	.....	$107,500
Germania Station	.....	22,630	22,630	.....	.....	.....	.....	.....	.....	.....	$22,630	22,630
Leeds District	.....	468,451	468,451	.....	218,244	218,244	.....	.....	.....	.....	250,207	250,207
Lewiston	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Park City	.....	650,172	650,172	.....	644,747	644,747	.....	$5,425	$5,425	.....	.....	.....
Silver Reef	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tintic District	34,700	1,713	36,413	$34,700	.....	34,700	.....	.....	.....	.....	1,713	1,713
Total	142,200	1,150,166	1,292,366	34,700	870,191	904,891	.....	5,425	5,425	107,500	274,550	382,050

From—	During six months ending June 30, 1880.			Shipped to—						Totals for the year ending June 30, 1880.		
				New York.			San Francisco.					
	Gold.	Silver.	Total.	Gold.	Silver.	Total.	Gold.	Silver.	Total.	Gold.	Silver.	Total.
Bingham	$50,300	.....	$50,300	.....	.....	.....	$50,300	.....	$50,300	$157,800	$7,200	$165,000
Germania Station	.....	$35,340	35,340	.....	.....	.....	.....	$35,340	35,340	.....	57,970	57,970
Leeds District	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	468,451	468,451
Lewiston	.....	8,150	8,150	.....	$8,150	$8,150	.....	.....	.....	.....	8,150	8,150
Park City	.....	468,374	468,374	.....	468,374	468,374	.....	.....	.....	.....	1,118,546	1,118,546
Silver Reef	.....	529,677	529,677	.....	358,089	358,089	.....	171,588	171,588	.....	529,677	529,677
Tintic District	22,953	.....	22,953	$22,953	.....	22,953	.....	.....	.....	57,853	1,713	59,366
Total	73,253	1,041,541	1,114,794	22,953	834,613	857,566	50,300	206,928	257,228	215,453	2,191,707	2,407,160

FOREIGN MOVEMENT.—The exports and imports of treasure are recorded at the custom-houses of the ports through which the outflow and the inflow pass. Such statistics are compiled with great care, and furnish valuable information from a monetary point of view. Used as a means of determining the bullion production of the country they are often deceptive, as explained on a previous page. The figures for the various offices are published regularly by the Bureau of Statistics, and are therefore not repeated here; but an analysis of the returns of the San Francisco custom-house is appended, to show the character of the movement, and as affording a basis of a comparison between similar periods at the beginning and close of the census year.

TABLE CLXXXVI.—TREASURE MOVEMENT THROUGH SAN FRANCISCO CUSTOM-HOUSE.

IMPORTS.

Month.	Gold bullion.	Gold coin.		Total gold.	Silver bullion.	Silver coin.			Total silver.	Total gold and silver.
		Foreign.	Domestic.			Foreign.	Domestic.	Trade dollars.		
June, 1879	$40,252	$206	$3,656	$44,113	$74,477	$254,705	$20,950	.....	$350,132	$394,245
July, 1879	80,862	.....	11,994	92,856	122,698	191,721	20,210	.....	335,629	428,485
August, 1879	127,484	1,700	6,467	135,651	122,878	200,592	17,030	$3,420	343,920	479,571
September, 1879	147,125	4,835	10,689	162,649	101,653	159,380	9,896	.....	270,929	433,578
October, 1879	100,222	620	16,601	117,443	153,374	213,579	13,414	.....	380,367	497,810
November, 1879	237,451	71,240	15,257	323,948	86,211	129,873	12,853	25,015	253,952	577,900
December, 1879	83,921	146,555	8,596	233,072	76,698	345,276	15,467	40,500	477,941	711,013
January, 1880	7,054	115,900	9,900	132,854	83,369	251,322	5,853	.....	340,544	473,398
February, 1880	46,650	15,500	3,929	66,079	238,000	93,781	7,517	15,000	354,298	420,377
March, 1880	37,932	32,412	6,809	77,153	120,084	401,751	28,164	.....	549,999	627,152
April, 1880	.....	21,521	35,883	57,404	135,710	354,695	11,509	.....	501,914	560,318
May, 1880	20,601	.....	40,353	60,954	123,370	125,851	116,388	.....	362,609	423,563
Total	929,554	404,488	170,194	1,504,176	1,439,522	2,719,526	279,251	83,935	4,522,234	6,026,410

TABLE CLXXXVI.—TREASURE MOVEMENT THROUGH SAN FRANCISCO CUSTOM-HOUSE—Continued.

Comparison between treasure imports in June, 1879, and June, 1880.

Month.	Gold bullion.	Gold coin.		Total gold.	Silver bullion.	Silver coin.			Total silver.	Total gold and silver.
		Foreign.	Domestic.			Foreign.	Domestic.	Trade dollars.		
June, 1879	$40,252	$205	$3,656	$44,113	$74,477	$254,705	$20,950	.....	$350,132	$394,245
June, 1880	52,976	.....	27,926	80,902	107,670	180,489	9,119	.....	297,278	378,180
Increase	12,724	.....	24,270	36,789	33,193	.....	.....	.....	.....	.....
Decline	.....	205	.....	.....	.....	74,216	11,831	.....	52,854	16,065

EXPORTS (DOMESTIC).

Month.	(a)Gold bullion.	Gold coin.	Total gold.	Silver bullion.	Silver coin.		Total silver.	Total gold and silver.
					Standard dollars.	Trade dollars.		
June, 1879	$100	$80,343	$80,443	$206,843	.....	$27,888	$234,731	$315,174
July, 1879	1,280	39,360	40,640	155,609	$21,400	7,962	184,371	225,011
August, 1879	3,060	26,788	29,868	804,622	.....	7,390	812,012	841,880
September, 1879	2,645	11,393	14,038	529,838	.....	13,325	543,163	557,201
October, 1879	13,635	40,230	53,865	347,804	240	11,900	359,944	413,809
November, 1879	8,615	53,572	62,487	192,718	.....	1,406	194,124	256,611
December, 1879	8,801	91,800	100,601	1,154,738	1,000	400	1,156,138	1,256,739
January, 1880	.....	11,915	11,915	419,685	550	.....	420,165	432,080
February, 1880	1,367	18,207	19,574	289,125	19,226	1,000	289,351	308,925
March, 1880	286	14,373	14,659	17,700	102,600	.....	120,300	134,959
April, 1880	550	31,042	31,592	72,001	500	.....	72,501	104,093
May, 1880	.....	48,513	48,513	666,299	9,000	.....	675,299	723,812
Total	40,359	467,836	508,195	4,836,362	154,466	71,271	5,062,099	5,570,294

Comparison between treasure exports (domestic) in June, 1879, and June, 1880.

June, 1879	$100	$80,343	$80,443	$206,843	.....	$27,888	$234,731	$315,174
June, 1880	1,020	55,534	56,554	34,452	$21,600	.....	56,052	112,606
Increase	920	.....	.....	.....	21,600	.....	.....	.....
Decline	.....	24,809	23,889	172,391	.....	27,888	178,679	202,568

EXPORTS (FOREIGN RE-EXPORTED).

Month.	Gold bullion.	Gold coin.	Total gold.	Silver bullion.	(b) Silver coin.	Total silver.	Total gold and silver.
June, 1879	.....	.....	.....	$45,600	$65,433	$111,033	$111,033
July, 1879	.....	$1,990	$1,990	13,900	157,490	171,390	173,380
August, 1879	.....	.....	.....	.....	212,421	212,421	212,421
September, 1879	.....	.....	.....	.....	149,308	149,308	149,308
October, 1879	.....	.....	.....	.....	324,730	324,730	324,730
November, 1879	.....	.....	.....	.....	146,205	146,205	146,205
December, 1879	.....	2,452	2,452	.....	251,522	251,522	251,522
January, 1880	.....	.....	.....	.....	140,214	140,214	140,214
February, 1880	.....	.....	.....	.....	325,913	325,913	325,913
March, 1880	.....	.....	.....	.....	205,231	205,231	205,231
April, 1880	.....	.....	.....	.....	110,300	110,300	110,300
May, 1880	.....	.....	.....	.....	487,747	487,747	487,747
Total	.....	4,442	4,442	59,500	2,576,514	2,636,014	2,640,456

Comparison between treasure exports (foreign re-exported) in June, 1879, and June, 1880.

June, 1879	.....	.....	.....	$45,600	$65,433	$111,033	$111,033
July, 1880	.....	.....	.....	.....	102,819	102,819	102,819
Increase	.....	.....	.....	.....	37,386	.....	.....
Decline	.....	.....	.....	45,600	.....	8,214	8,214

a Gold bullion includes gold dust.

b The greater part of the silver coin is Mexican dollars.

FINAL DISPOSITION OF THE PRECIOUS METALS—COINAGE.

The receipts of bullion of domestic production at the United States assay offices, as previously explained, do not indicate the absolute amount of the mine output, but they serve as a useful check in many instances. The following tables are abstracts from the carefully collected statistics of the Treasury Department, selected with reference to their bearing upon the question of production.

TABLE CLXXXVII.—RECEIPTS AT THE MINTS AND UNITED STATES ASSAY OFFICES.

Deposits of gold of domestic production during the fiscal year ended June 30, 1880.

State or territory.	Mints.					Assay offices.				Total.
	Philadelphia.	San Francisco.	Carson.	Denver.	New Orleans.	New York.	Boisé.	Helena.	Charlotte.	
	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.
Alabama	665 94					86 85				752 79
Alaska		5,950 90								5,950 90
Arizona	4,070 85	152,967 26	367 91			1,513 73				158,919 75
California	8,752 54	7,033,656 05	25,389 85		2,350 43	48,667 55				7,118,816 42
Colorado	1,420 39	338 72		344,756 91		1,897,553 72				2,244,069 74
Dakota	971 58	64,350 06				2,684,700 45				2,750,022 09
Georgia	28,923 24					44,733 60			16,174 15	89,831 08
Idaho	4,565 31	365,570 55	1,374 64			20,919 24	116,309 87	1,807 62		510,546 73
Montana	656 41	16,441 84				1,324,962 19		463,687 56		1,805,768 00
Nevada		38,119 81	346,837 45			139,304 59				518,261 85
New Mexico	607 82					90,429 46				91,037 28
North Carolina	14,159 73					14,543 55			56,936 29	85,659 57
Oregon		552,280 41					31,084 93			583,365 34
South Carolina	2,493 26								9,368 44	11,861 70
Tennessee	1,907 95					90 35				1,998 30
Utah	401 22	13,295 30	204 66			13,128 01				27,029 19
Virginia	7,851 24					1,470 83				9,322 07
Washington		34,529 24								34,529 24
Wyoming	11,174 63	328 84		152 95		5,664 28				17,320 70
Refined bullion		18,161,943 52								18,161,943 52
Parted from silver	24,041 43	1,106,868 07				318,615 04				1,449,524 54
Contained in silver							224 86	936 61		1,161 47
Other sources	12,921 26					131,000 74			91 13	144,013 13
Total	125,584 80	27,546,640 57	368,174 51	344,909 86	2,350 43	6,737,404 27	147,619 16	466,431 79	82,590 01	35,821,705 40

Deposits and purchases of silver of domestic production during the fiscal year ended June 30, 1880.

Arizona	121,438 31	831,016 67	12 58			38,855 82				991,323 38
California		283,734 46	19,331 05			781 40				303,846 91
Colorado				4,443 77		1,253,346 64				1,257,790 41
Dakota						21,104 54				21,104 54
Georgia									48 73	48 73
Idaho		88,724 16	24 72			14,152 95	41 29	56 74		102,999 86
Michigan (Lake Superior)	3,230 96					126,455 98				129,686 94
Montana	6,813 52	259,086 30				937,475 44		59,607 06		1,262,982 32
Nevada		4,123,732 53	602,920 00			360,589 65				5,087,242 18
New Mexico						424,967 31				424,967 31
North Carolina									379 18	379 18
Oregon		1,174 26								1,174 26
South Carolina									15 52	15 52
Utah	3,373 41	11,827 38	3 53			612,499 53				627,703 85
Refined bullion		2,970,757 92								2,970,757 92
Parted from gold	22,557 99	78,278 43				118,550 84				219,387 26
Contained in gold							2,011 54	966 69		2,978 23
Other sources	15,440,268 77	1,319,294 48			1,942,936 12	25,928 46			32	18,728,368 15
Total	15,597,682 96	9,967,566 59	622,291 88	4,443 77	1,942,936 12	3,934,708 56	2,052 83	60,630 49	443 75	32,132,756 95

Receipts of gold and silver of domestic production at the mints and United States assay offices during fiscal year ended June 30, 1880.

State or territory.	Gold.	Silver.	Total.
	Dollars.	Dollars.	Dollars.
Alabama	752 79		752 79
Alaska	5,950 90		5,950 90
Arizona	158,919 75	991,323 38	1,150,243 13
California	7,118,816 42	303,846 91	7,422,663 33
Colorado	2,244,069 74	1,257,790 41	3,501,860 15
Dakota	2,756,022 09	21,104 54	2,771,126 63
Georgia	89,831 08	48 73	89,879 81
Idaho	510,546 73	102,999 86	613,546 59
Michigan (Lake Superior)		129,686 94	129,686 94
Montana	1,805,768 00	1,262,982 32	3,068,750 32
Nevada	518,261 85	5,087,342 18	5,605,504 03
New Mexico	91,037 28	424,967 31	516,004 59
North Carolina	85,659 57	379 18	86,038 75
Oregon	583,365 34	1,174 26	584,539 60
South Carolina	11,861 79	15 52	11,877 22
Tennessee	1,098 30		1,098 30
Utah	27,029 19	627,703 85	654,733 04
Virginia	9,322 07		9,322 07
Washington	34,529 24		34,529 24
Wyoming	17,320 70		17,320 70
Refined bullion (gold)	18,161,943 52		18,161,943 52
Refined bullion (silver)		2,970,757 92	2,970,757 92
Parted from silver	1,449,524 54		1,449,524 54
Parted from gold		219,387 26	219,387 26
Contained in silver	1,161 47		1,161 47
Contained in gold		2,978 23	2,978 23
Other sources (gold)	144,013 13		144,013 13
Other sources (silver)		18,728,368 15	18,728,368 15
Total	35,821,765 40	32,122,756 95	67,954,462 35

Gold and silver of domestic production deposited at the mints and assay offices from their organization to the close of the fiscal year ended June 30, 1880.

Alabama	219,872 95		219,872 95
Alaska	29,972 47		29,972 47
Arizona	2,256,742 06	2,116,717 64	4,373,459 70
California	702,058,970 35	1,677,550 45	703,736,520 80
Colorado	35,417,517 84	20,183,889 56	55,601,407 10
Dakota	7,235,112 89	21,121 54	7,256,234 43
Georgia	7,698,092 03	458 20	7,698,540 23
Idaho	24,137,417 11	727,295 50	24,864,712 61
Maryland	402 13		402 13
Massachusetts		917 56	917 56
Michigan (Lake Superior)	122 99	3,433,674 78	3,433,708 77
Montana	49,689,006 09	4,371,384 12	53,060,390 21
Nevada	14,432,322 55	72,107,030 69	86,539,353 24
New Mexico	11,020 55		11,020 55
North Carolina	1,569,472 14	2,221,484 63	3,790,956 77
Oregon	10,613,351 10	45,581 33	10,658,932 43
South Carolina	15,414,509 57	4,406 38	15,418,915 95
Tennessee	1,401,845 30	30 44	1,401,875 74
Utah	84,266 25		84,266 25
Vermont	445,133 61	9,036,957 01	9,482,090 62
Virginia	10,961 27		10,961 27
Washington	1,672,667 70		1,672,667 70
Wyoming	208,959 37		208,959 37
Refined bullion	716,966 47	11,793 86	728,760 33
Parted from silver	201,055,915 26	42,790,012 87	243,845,928 13
Contained in silver	13,974,774 89		13,974,774 89
Parted from gold	9,322,268 97		9,322,268 97
Contained in gold		6,813,478 84	6,813,478 84
Other sources		520,623 81	520,623 81
Total	10,243,731 33	31,337,203 76	41,579,935 09
	1,166,920,405 89	197,421,613 97	1,364,342,019 86

The following table shows the amount of coinage executed during the fiscal year ending June 30, 1880, and the total coinage of the United States up to that date:

TABLE CLXXXVIII.—AMOUNT OF COINAGE EXECUTED DURING FISCAL YEAR ENDING JUNE 30, 1880, AND TOTAL COINAGE OF THE UNITED STATES UP TO THAT DATE.

GOLD COINAGE FOR FISCAL YEAR ENDING JUNE 30, 1880.		SILVER COINAGE FOR FISCAL YEAR ENDING JUNE 30, 1880.		TOTAL COINAGE FOR FISCAL YEAR ENDING JUNE 30, 1880.		TOTAL COINAGE FROM 1793 TO CLOSE OF FISCAL YEAR ENDING JUNE 30, 1880.	
Denomination.	Coinage executed.	Denomination.	Coinage executed.	Metal.	Coinage executed.	Metal.	Coinage executed.
Double-eagles	$21, 515, 360 00	Dollars	$27, 963, 750 00	Gold	$56, 157, 735 00	Gold	$1, 133, 103, 322 00
Eagles	18, 836, 320 00	Half-dollars	3, 275 00	Silver	27, 942, 437 50	Silver	292, 333, 436 90
Half-eagles	15, 790, 860 00	Quarter-dollars	3, 837 50				
Three-dollars	9, 000 00	Dimes	1, 575 00				
Quarter-eagles	3, 075 00			Total gold and silver coinage	84, 100, 172 50	Total gold and silver coinage	1, 425, 436, 758 90
Dollars	3, 030 00			Minor coinage	269, 971 50	Minor coinage	13, 283, 167 05
Total	56, 157, 735 00	Total	27, 942, 437 50	Total coinage	84, 370, 144 00	Total coinage	1, 438, 719, 925 95

CONSUMPTION OF THE PRECIOUS METALS IN THE ARTS.

Besides the demand for coinage and export, the precious metals are subjected to a further and constant drain in the large annual consumption in the arts. Until quite recently it was impossible to ascertain the amount so absorbed with any degree of accuracy, though many attempts were made to this end by officials and statisticians. In 1870 estimates furnished by the large gold-refining houses and manufacturing jewelers showed that probably not less than $9,000,000, and possibly over $13,000,000, of gold were used in the arts during that year. Out of this indefinite sum it was impossible to segregate the proportion of bullion of domestic production so consumed from the United States coin, foreign coin and bullion, and old articles remelted for manufacturing purposes.

Latterly fuller and more reliable data are available. A systematic investigation, conducted by the director of the mint, Hon. Horatio C. Burchard, has resulted in tracing this consumption with great accuracy. Records are now kept at the several mints and United States assay offices of the value of bars made and delivered by them for use in the arts and manufacturing. From these returns, supplemented by individual reports from a large proportion of the manufacturing establishments, collected with much care, it is estimated that the amount of gold thus consumed in the United States in the fiscal year ending June 30, 1880, was $10,000,000, and of silver $5,000,000, or $15,000,000 in all. Of this $5,500,000 gold and $4,000,000 silver were of domestic bullion produced during the year, together with $2,500,000 gold and $600,000 silver United States coin. The remainder consisted of old manufactured articles and foreign coin remelted.

This large amount is absorbed mainly in the following principal industries: The manufacture of jewelry, plate, and plated ware, and articles of *vertu;* watch-case, gold pen, instrument, and spectacle making; dentistry; gilding and plating; photography; and to a less extent in glass staining and in various chemical processes. In addition to the leading uses enumerated, there are many others, insignificant individually, but in the aggregate demanding a considerable supply of the precious metals.

Some idea of the relative proportion in which the principal manufacturing industries consume the precious metals may be gathered from the following table, exhibiting the value of the gold and silver used in manufactures and the arts in the United States during the fiscal year ending June 30, 1880, as reported by persons and firms engaged in the manufactures named, in response to circular inquiries addressed from the bureau of the mint:

TABLE CLXXXIX.—COMPARATIVE CONSUMPTION OF THE PRECIOUS METALS IN THE INDUSTRIES AND ARTS.

Manufactures of—	Gold.	Silver.	Total.
Watches and jewelry	$6, 517, 966	$959, 642	$7, 477, 628
Watch-cases and manufactures	1, 202, 872	1, 817, 248	3, 020, 120
Gold leaf and plate	850, 929	606, 329	1, 457, 258
Chemicals	55, 410	76, 519	131, 929
Instruments	6, 996	4, 432	11, 428
Total	8, 634, 193	3, 464, 170	12, 098, 363

OTHER ESTIMATES OF THE BULLION PRODUCT.

As a means of comparison, several independent estimates, derived from different sources of information and compiled upon widely diverse systems, are appended. They are:

1. Estimates of Dr. Adolf Soetbeer (as published in *Petermann's Mittheilungen*, Ergänzungsheft No. 57) of the product of the United States up to the close of 1875; kilograms being converted into troy ounces and German marks into United States money. The conclusions reached by Dr. Soetbeer were based upon an analytical study and comparison of the literature of the subject, and are generally accepted with confidence.

2. Estimates of Hon. Horatio C. Burchard, director of the mint, founded upon the "consumption and export" system, supplemented by circular inquiries among the producers. The director, in his annual report for 1880, states the gross product for that fiscal year in round numbers as $36,000,000 gold, $37,700,000 silver (coinage value), and $73,700,000 total.

3. Estimates of Mr. J. J. Valentine, general superintendent of Wells, Fargo & Co.'s Express, based on the transportation statistics of that and other express companies.

4. Estimates of Dr. Rossiter W. Raymond, formerly United States mining commissioner, for the period covered by his official term.

5. Miscellaneous estimates.

TABLE CXC.—DR. SOETBEER'S ESTIMATE OF THE PRODUCTION OF THE PRECIOUS METALS IN THE UNITED STATES TO THE CLOSE OF 1875.

Periods.	Number of years.	Gold product.			Silver product.		
		Total.	Yearly average.	Value.	Total.	Yearly average.	Value.
		Ounces.	Ounces.	Dollars.	Ounces.	Ounces.	Dollars.
1804–'20	17	1,929	113	39,876			
1821–'30	10	35,368	3,537	731,121			
1831–'40	10	273,295	27,329	5,649,509			
1841–'50	10	5,658,825	565,883	116,978,291			
1851–'55	5	14,275,673	2,855,135	295,194,343	1,334,325	266,865	1,725,149
1856–'60	5	12,394,757	2,478,951	256,222,359	996,725	199,345	1,288,666
1861–'65	5	10,722,832	2,144,566	221,660,603	27,972,602	5,594,520	36,165,777
1866–'70	5	12,217,918	2,443,584	252,566,773	48,389,387	9,677,877	62,562,638
1871–'75	5	9,565,344	1,913,069	197,733,203	90,798,425	18,159,685	117,393,284
Total	72	65,145,941	12,432,167	1,346,673,078	169,491,464	33,896,292	219,135,514

TABLE CXCI.—ESTIMATE OF THE PRODUCTION OF THE PRECIOUS METALS IN THE UNITED STATES FROM 1848 TO 1880, BY FISCAL YEARS.

[From reports of Hon. Horatio C. Burchard, director of the mint.]

Year.	Gold.	Silver.	Total gold and silver.	Year.	Gold.	Silver.	Total gold and silver.	Year.	Gold.	Silver.	Total gold and silver.
	Dollars.	Dollars.	Dollars.		Dollars.	Dollars.	Dollars.		Dollars.	Dollars.	Dollars.
1848...	10,000,000		10,000,000	1860...	46,000,000	150,000	46,150,000	1872...	36,000,000	28,750,000	64,750,000
1849...	40,000,000	50,000	40,050,000	1861...	43,000,000	2,000,000	45,000,000	1873...	36,000,000	35,750,000	71,750,000
1850...	50,000,000	50,000	50,050,000	1862...	39,200,000	4,500,000	43,700,000	1874...	33,490,902	37,324,594	70,815,496
1851...	55,000,000	50,000	55,050,000	1863...	40,000,000	8,500,000	48,500,000	1875...	33,467,856	31,727,560	65,195,416
1852...	60,000,000	50,000	60,050,000	1864...	46,000,000	11,000,000	57,000,000	1876...	39,929,166	38,783,016	78,712,182
1853...	65,000,000	50,000	65,050,000	1865...	53,225,000	11,250,000	64,475,000	1877...	46,897,390	39,793,573	86,690,963
1854...	60,000,000	50,000	60,050,000	1866...	53,500,000	10,000,000	63,500,000	1878...	51,206,360	45,281,385	96,487,745
1855...	55,000,000	50,000	55,050,000	1867...	51,725,000	13,500,000	65,225,000	1879...	38,899,858	40,812,132	79,711,990
1856...	55,000,000	50,000	55,050,000	1868...	48,000,000	12,000,000	60,000,000	1880...	36,000,000	37,700,000	73,700,000
1857...	55,000,000	50,000	55,050,000	1869...	49,500,000	12,000,000	61,500,000	Total.	1,520,041,532	460,422,269	1,980,463,792
1858...	50,000,000	50,000	50,050,000	1870...	50,000,000	16,000,000	66,000,000				
1859...	50,000,000	100,000	50,100,000	1871...	43,000,000	23,000,000	66,000,000				

TABLE CXCII.—BULLION PRODUCTION OF THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1879.

[Estimated by Hon. Horatio C. Burchard, director of the mint.]

State or territory.	Gold.	Silver.	Total.
Arizona	$800,000	$3,550,000	$4,350,000
California	17,600,000	2,400,000	20,000,000
Colorado	3,225,000	11,700,000	14,925,000
Dakota	2,420,000	10,000	2,430,000
Georgia	90,000		90,000
Idaho	1,200,000	650,000	1,850,000
Michigan (Lake Superior) (a)		780,000	780,000
Montana	2,500,000	2,225,000	4,725,000
Nevada	9,000,000	12,560,000	21,560,000
New Mexico	125,000	600,000	725,000
North Carolina	90,000		90,000
Oregon	1,150,000	20,000	1,170,000
Utah	575,000	6,250,000	6,825,000
Washington	75,000	20,000	95,000
Other sources	50,000	47,000	97,000
Total	38,900,000	40,812,000	79,712,000

a Including bullion from Silver Islet, which is in Canada.

TABLE CXCIII.—STATEMENT OF THE AMOUNT OF PRECIOUS METALS PRODUCED IN THE

[Estimated by Mr. John J. Valentine, general

	State or territory.	Gold dust and bullion by express.				Gold dust and bullion by other conveyances.			
		1879.	1880.	Increase.	Decrease.	1879.	1880.	Increase.	Decrease.
		Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
1	California	16,348,739	16,900,745	552,015		817,436	845,000	27,564	
2	Nevada	168,847	236,323	67,476					
3	Oregon	943,601	692,525		251,076	94,360	346,262	251,902	
4	Washington	77,579	68,911		8,668	7,757	34,500	26,743	
5	Idaho	1,035,804	1,175,115	139,311		207,160	235,023	27,863	
6	Montana	1,907,053	1,115,787		791,266	95,352	55,789		39,563
7	Utah	211,640	95,958		115,682	21,164	10,336		10,828
8	Colorado	3,144,697	2,278,989		865,708	314,469			314,469
9	New Mexico	19,800	27,300	7,500					
10	Arizona	212,722	159,970		52,752	21,272	80,000	58,728	
11	Dakota	2,674,156	3,749,081	1,074,925		534,831	374,000		160,831
	Total	26,744,629	26,500,704	1,841,227	2,085,153	2,113,801	1,980,910	392,800	525,691
	Increase								
	Decrease				243,925				132,891

TABLE CXCIV.—STATEMENT OF THE AMOUNT OF PRECIOUS METALS PRODUCED IN

[Estimated by Mr. John J. Valentine, general

	Country.	Gold dust and bullion by express.				Gold dust and bullion by other conveyances.			
		1879.	1880.	Increase.	Decrease.	1879.	1880.	Increase.	Decrease.
		Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
1	Mexico (west coast)	92,916	118,248	25,332					
2	British Columbia	976,742	675,894		300,848		168,973	168,973	
	Total	1,069,658	794,142	25,332	300,848		168,973	168,973	
	Increase							168,973	
	Decrease				275,516				

STATES AND TERRITORIES WEST OF THE 100TH MERIDIAN FOR THE YEARS 1879 AND 1880.

superintendent, Wells, Fargo & Co.'s Express.]

Silver bullion by express.				Ores and base bullion by freight.				Total.				
1879.	1880.	Increase.	Decrease.	1879.	1880.	Increase.	Decrease.	1879.	1880.	Increase.	Decrease.	
Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	
739,440	378,567	.....	360,873	285,367	151,854	.....	133,513	18,100,973	18,276,186	85,193	.....	1
16,622,472	11,071,992	.....	5,550,480	5,206,395	3,723,306	.....	1,483,089	21,997,714	15,031,621	.....	6,966,093	2
.....	20,854	20,854	.....	.....	.....	.....	.....	1,037,961	1,059,641	21,680	.....	3
.....	1,753	1,753	.....	.....	.....	.....	.....	85,336	105,164	19,828	.....	4
578,336	332,755	.....	245,581	270,000	151,854	.....	118,146	2,091,300	1,894,747	.....	196,553	5
1,194,389	919,189	.....	275,200	432,226	1,731,614	1,299,388	.....	3,629,020	3,822,379	193,359	.....	6
2,559,042	3,076,775	517,733	.....	2,677,033	3,967,884	590,851	.....	5,468,879	6,450,953	982,074	.....	7
1,594,349	1,706,000	111,651	.....	9,360,000	17,300,000	7,940,000	.....	14,413,515	21,284,969	6,871,474	.....	8
603,000	684,000	81,000	.....	.....	.....	.....	.....	622,800	711,300	88,500	.....	9
1,046,036	2,830,449	1,784,413	.....	662,373	1,402,052	739,679	.....	1,942,403	4,472,471	2,530,068	.....	10
.....	.....	.....	.....	.....	.....	.....	.....	3,208,987	4,121,081	914,094	.....	11
24,937,064	21,022,334	2,517,404	6,432,134	18,893,394	27,728,564	10,569,918	1,734,748	72,688,888	77,232,512	11,706,270	7,162,646	
.....	.....	.....	.....	.....	.....	8,835,170	.....	.....	.....	4,543,624	.....	
.....	.....	.....	3,914,730	.....	.....	.....	.....	.....	.....	.....	.....	

MEXICO (WEST COAST) AND BRITISH COLUMBIA FOR THE YEARS 1879 AND 1880.

superintendent, Wells, Fargo & Co.'s Express.]

Silver bullion by express.				Ores and base bullion by freight.				Total.				
1879.	1880.	Increase.	Decrease.	1879.	1880.	Increase.	Decrease.	1879.	1880.	Increase.	Decrease.	
Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	
1,249,955	1,586,309	336,354	.....	341,000	386,000	45,000	.....	1,683,871	2,090,557	406,686	.....	1
.....	.....	.....	.....	.....	.....	.....	.....	976,742	844,867	.....	131,875	2
1,249,955	1,586,309	336,354	.....	341,000	386,000	45,000	.....	2,660,613	2,935,424	406,686	131,875	
.....	.....	336,354	.....	.....	.....	45,000	.....	.....	.....	274,811	.....	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	

TABLE CXCV.—ANNUAL PRODUCTS OF LEAD, SILVER, AND GOLD IN THE STATES AND TERRITORIES WEST OF THE 100TH MERIDIAN, 1870–1880.

[Estimated by Mr. John J. Valentine, general superintendent, Wells, Fargo & Co.'s Express.]

Year.	Products as per W., F. & Co.'s statements, including amounts from British Columbia and west coast of Mexico.	Product after deducting amounts from British Columbia and west coast of Mexico.	The net product of the states and territories west of the 100th meridian exclusive of British Columbia and west coast of Mexico, divided as follows—			
			Lead.	Copper.	Silver.	Gold.
	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.
1870	54, 000, 000	52, 150, 000	1, 080, 000	.....	17, 220, 000	33, 750, 000
1871	58, 284, 000	55, 784, 000	2, 100, 000	.....	19, 288, 000	34, 396, 000
1872	62, 236, 959	60, 351, 824	2, 250, 000	.....	19, 924, 429	38, 177, 395
1873	72, 258, 693	70, 139, 880	3, 450, 000	.....	27, 483, 302	39, 206, 578
1874	74, 401, 045	71, 965, 610	3, 800, 000	.....	29, 699, 122	38, 466, 488
1875	80, 899, 057	76, 703, 433	5, 160, 000	.....	31, 635, 239	39, 968, 194
1876	90, 875, 173	87, 219, 859	5, 040, 000	.....	39, 292, 924	42, 886, 935
1877	98, 421, 754	95, 811, 582	5, 085, 250	.....	45, 846, 109	44, 880, 223
1878	81, 154, 622	78, 276, 167	3, 452, 000	.....	37, 248, 127	37, 576, 030
1879	75, 349, 501	72, 688, 888	4, 185, 769	.....	37, 032, 857	31, 470, 262
1880	80, 167, 936	77, 232, 512	5, 742, 390	898, 000	38, 033, 055	32, 559, 067

TABLE CXCVI.—BULLION PRODUCTION OF THE UNITED STATES FROM 1868 TO 1875.

[Estimated by Dr. Rossiter W. Raymond, United States mining commissioner.]

State or territory.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.
	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.
California	22, 000, 000	22, 500, 000	25, 000, 000	20, 000, 000	19, 049, 098	18, 025, 722	20, 306, 531	17, 753, 151
Nevada	14, 000, 000	14, 000, 000	16, 000, 000	22, 500, 000	25, 548, 801	35, 254, 507	35, 452, 233	40, 478, 369
Montana	15, 000, 000	9, 000, 000	9, 100, 000	8, 050, 000	6, 068, 339	5, 187, 047	3, 844, 722	3, 573, 600
Idaho	7, 000, 000	7, 000, 000	6, 000, 000	5, 000, 000	2, 695, 870	2, 500, 000	1, 880, 004	1, 750, 000
Oregon and Washington	4, 000, 000	3, 000, 000	3, 000, 000	2, 500, 000	2, 000, 000	1, 585, 784	763, 605	1, 246, 978
Arizona	500, 000	1, 000, 000	800, 000	800, 000	625, 000	500, 000	497, 000	750, 000
New Mexico	250, 000	500, 000	500, 000	500, 000	500, 000	500, 000	500, 000	325, 000
Colorado and Wyoming	3, 250, 000	4, 000, 000	3, 775, 000	4, 763, 000	4, 761, 465	4, 070, 263	5, 188, 510	5, 302, 810
Utah	.....	.....	1, 300, 000	2, 800, 000	2, 445, 284	3, 778, 200	3, 911, 601	3, 137, 688
From other parts	1, 000, 000	500, 000	525, 000	250, 000	250, 000	250, 000	100, 000	500, 000
Total	67, 000, 000	61, 500, 000	66, 000, 000	66, 063, 000	63, 943, 857	71, 651, 523	72, 428, 206	74, 817, 596

TABLE CXCVII.—GOLD PRODUCTION OF THE SOUTHERN STATES FROM 1804 TO 1850.

[Estimates of Professor J. D. Whitney.]

Value of gold production by states.

Georgia	$6, 048, 900
North Carolina	6, 842, 900
South Carolina	818, 100
Tennessee and Alabama	263, 800
Virginia	1, 198, 600
Total	15, 172, 300

Value of gold production in the respective divisions of time.

1804–'23	$47, 000
1824–'30	715, 000
1831–'40	6, 695, 000
1841–'50	7, 715, 300
Total	15, 172, 300

TABLE CXCVIII.—EXPORTS OF GOLD FROM SAN FRANCISCO FROM 1848 TO 1863.

[With estimates of Mr. W. P. Blake.]

Year.	Declared gold export.	Estimated actual gold export.	Year.	Declared gold export.	Estimated actual gold export.
1848	$66, 000, 000	$10, 000, 000	1857	$48, 976, 692	$55, 000, 000
1849		40, 000, 000	1858	47, 548, 026	50, 000, 000
1850		50, 000, 000	1859	47, 040, 462	50, 000, 000
1851 up to May 1	11, 497, 000	55, 000, 000	1860	42, 325, 916	42, 325, 916
1851	34, 960, 895		1861	40, 676, 758	39, 176, 758
1852	45, 779, 000	60, 000, 000	1862	42, 561, 761	38, 061, 761
1853	54, 965, 000	65, 000, 000	1863	46, 071, 920	33, 071, 920
1854	52, 045, 633	60, 000, 000			
1855	45, 161, 731	55, 000, 000	Total	676, 908, 228	755, 636, 355
1856	50, 697, 434	55, 000, 000			

TABLE CXCIX.—MR. A. DEL MAR'S ESTIMATE OF THE SILVER PRODUCTION FROM 1871 TO 1876.

District.	1871.		1872.		1873.		1874.		1875.		1876.	
	Gold product.	Silver product.	Gold product.	Silver product.	Gold product.	Silver product.	Gold product.	Silver product.	Gold product.	Silver product.	Gold product.	Silver product.
	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.
Comstock lode	4,077,427	6,230,567	6,310,095	8,612,943	10,493,756	11,037,039	12,579,835	11,881,000	11,738,873	14,492,350	18,002,908	20,570,078
Other mines in Nevada	1,485,007	7,880,784	2,142,730	9,953,634	2,678,469	8,094,440	1,650,202	3,531,382	2,256,618	6,717,636	1,337,788	7,462,752
Whole of Nevada	5,562,434	14,111,351	8,452,765	18,566,577	13,172,225	19,131,480	14,230,027	15,402,382	13,995,491	21,209,986	19,340,794	28,032,830
Remainder of the United States		4,000,000		2,000,000		6,000,000		10,000,000		9,000,000		10,151,520
Entire silver product		18,111,351		18,566,577		25,131,480		25,402,382		30,209,986		38,184,350

The silver product in the United States (with the exception of Nevada) is given for 1876 *as follows:*

Arizona	$500,000
California	1,600,000
Colorado	3,000,000
Idaho	300,000
Montana	800,000
New Mexico	400,000
Utah	3,351,520
Total, about	10,151,520

BULLION PRODUCT OF THE WORLD.

The world's annual output, so far as ascertainable, is shown in the following tables, which state the sources according to political divisions, and also by continents. The data are for calendar years except for the United States, British Columbia, and Japan. Accurate statistics of the small production of gold and silver in Central America, that of silver in Canada, and gold in Nova Scotia are not available. The totals given are probably slightly under the actual amount. A comparison of the individual figures shows that the United States produce 33.13 per cent. of the gold yield of the whole world, 50.54 per cent. of the silver, and 40.91 per cent. of the total. Of the aggregate supply of the precious metals, North America (including the United States, Mexico, and British Columbia) furnishes 55.78 per cent.

TABLE CC.—ANNUAL BULLION PRODUCT OF THE WORLD.

Political distribution.				Continental distribution.		
Country.	Gold.	Silver.	Total.	Continent.	Total bullion product.	Percentage of total product.
	Dollars.	Dollars.	Dollars.		Dollars.	Per cent.
United States (a)	33,379,663	41,110,957	74,490,620	North America	101,558,348	55.78
Mexico	969,161	25,167,763	26,156,924	Africa	1,993,800	1.10
British Columbia (b)	910,804		910,804	Australia	29,018,223	15.93
Africa (c)	1,993,800		1,993,800	Europe, including Russia in Asia	39,607,271	21.75
Argentine Republic	78,546	420,225	498,771	Japan	1,382,948	0.76
Colombia	4,000,000	1,000,000	5,000,000	South America	8,531,761	4.68
Rest of South America (c)	1,993,800	1,039,190	3,032,990			
Australia (d)	29,018,223		29,018,223	Total	182,092,351	100.00
Austria	1,062,031	2,002,727	3,064,758			
Germany (d)	205,981	6,938,073	7,143,424			
Norway		166,270	166,270			
Italy (d)	72,375	17,949	90,324			
Russia (d)	26,594,000	415,676	26,999,676			
Sweden	1,994	62,435	64,429			
Rest of Europe		2,078,380	2,078,380			
Japan	466,548	916,400	1,382,948			
Total	100,756,906	81,336,045	182,092,351			

a Census of 1880. b Actual export. c From Dr. Soetbeer's estimate in 1875. d Estimated from production of other years.

CHAPTER VIII.—THE MINTING OF GOLD AND SILVER

BY ALBERT WILLIAMS, JR.

A description of the means by which gold and silver are refined and made into coin forms a natural sequence to the description of the mining and metallurgical methods given in previous chapters. The following pages are designed to present merely a brief outline of the subject for the benefit of readers who may be unfamiliar with it. An exhaustive treatise on modern practice is much to be desired, but such a dissertation does not come within the scope of this volume. Two mints were selected for examination, that at Carson, Nevada, and that at San Francisco, California. The processes employed at these two establishments are in the main identical, though conducted upon an altogether different scale; and to avoid wearisome repetition of details the description of the system at the San Francisco mint is confined, so far as practicable, to the salient divergencies from the methods pursued at the smaller mint. Both mints now part by sulphuric acid, the nitric-acid process (formerly in exclusive use at the San Francisco mint) having been in large part supplanted by the cheaper sulphuric-acid process. In each case the officers extended every facility for inspection, and to them, and to all the employés, the writer is indebted for many courtesies.

UNITED STATES MINT AT CARSON, ORMSBY COUNTY, NEVADA.

The Carson mint, though much smaller and having far less working capacity than the similar establishments at San Francisco and Philadelphia, is nevertheless a fully-equipped mint, capable of meeting all ordinary requirements, and performs its work in an excellent manner. It was projected with the view of facilitating the minting of bullion from the Comstock mines, but for reasons unconnected with the simple question of proximity the greater part of the Comstock product has been treated at the San Francisco mint. The Carson mint having but slight, if any, advantages over its San Francisco rival in point of transportation from other mining districts, has, therefore, except during exceptional periods of activity, been limited in its operations to even less than its actual capacity, and at times has been shut down for months. This was the case during a large part of the census year. The examination was made in January, 1881.

LOCATION AND RAILROAD CONNECTIONS.—The site of the mint comprises a block on the west side of C street, Carson, one block south from the station of the Virginia and Truckee railroad. The mines of the Comstock and neighboring groups are distant from 20 to 25 miles; while the mills along the Carson river are at nearer intervals. From Virginia City to Carson by rail the distance is 21.1 miles. At Reno, 31.1 miles distant by rail from Carson, the Virginia and Truckee railroad connects with the Central Pacific railroad, thus bringing the mint into communication with the mining districts within reach of the latter road.

THE BUILDING.—The main building, designed by Mr. A. B. Mullett, then supervising architect of the Treasury Department, was completed in January, 1870, at a total cost of $160,000. It consists of two stories and a basement, the first floor being 15 feet high and the second story 14 feet. The area covered is 90 feet 6 inches by 59 feet 10 inches. The basement contains the annealing-room, cutting-room, grinding-room, hydraulic presses, drying furnaces, Chili mills, vaults, storerooms, and closets, and through it run the counter-shafts, with the pulleys driving the machinery on the first floor. The engine and boiler rooms are immediately in the rear and on the basement level. On the first floor are the weighing-room, deposit-melting and ingot-melting furnaces, ingot rolls, whitening-room, coining presses, machine-shop, offices of the cashier, coiner, and melter and refiner, and vaults. The second story is occupied by the superintendent's, assayer's, and chief clerk's offices, the laboratory, assay-room, humid assay-room, refinery, and adjusting rooms.

The walls are a rough-dressed freestone from the quarry of the Nevada state penitentiary, 1½ miles distant—a handsome building-stone, which is said to become indurated by exposure. Granite quarried 3½ miles from the site is used for the stairs. The shutters are of iron.

An extension in the rear of the main building, of the same general construction and appearance as the latter, and designed to contain the refinery (which was hampered for want of room in its original position), was unfinished at the date of examination. The first appropriation of $8,500 having been exhausted, a further sum of $5,000 would be required to complete this extension. There are five vaults in the main building provided with combination locks.

MACHINERY, ETC.—The machinery, appliances, and fittings, which will be described somewhat in detail, are of recent type throughout, and are well adapted to their several purposes. Their total cost, including alterations and repairs, is stated to have been, in round numbers, $100,000.

COST.—The total cost of construction and equipment of the mint, inclusive of the additional appropriation required, was:

Main building	$160,000
Extension	8,500
To complete extension	5,000
Machinery, fittings, etc	100,000
Total	273,500

This may be assumed as representing the cost of a first-class mint of moderate capacity.

ORGANIZATION.—The work of the mint is, for convenience and as a precaution against loss or error, divided among four distinct departments, which are designated as: *a*, The general department, under the immediate and special charge of the superintendent; *b*, the assayer's department; *c*, the melter and refiner; and, *d*, the coiner. These form separate corps, working independently, but accounting to each other. Over the whole the superintendent has, of course, supervision.

MINT TERMS.—Gold bullion and dust are deposited and returns made to the depositors in coin after minting, the gold coinage being free. Silver bullion is purchased at the market price, governed by the daily London quotations, with allowance for variation in exchange. The bullion purchased is 0.500 fine and over, at the discretion of the superintendent.

IMPROVEMENTS NEEDED.—Although the Carson mint has been described as a complete one, there are still a few slight improvements which might be advantageously added. Among these are:

a. A reverberatory cupel furnace, for treating bullion containing a large proportion of lead. At present the mint is carrying over from year to year bars which cannot be termed base, but which cannot be profitably refined by the sulphuric-acid process. As an average example of this class of bullion, the assay determination of bar No. 92, cast in 1879, is appended: Gold, 0.021; silver, 0.535; lead, 0.444.

b. Dust-chambers or condensing-flues connected with the main stack. Although the loss of precious metal is small, it could be still further reduced by these means.

c. Improved sulphuric acid condensers in the refinery.

In describing the operations of the mint in detail the natural sequence of the several manipulations will be observed, so far as is practicable, beginning with the receipt of the precious metals in their crude state, and then following them through the processes of melting, refining into mint-fine metal, alloying to the coin standard, casting the coin-metal into ingots, rolling the ingots to the required thickness, annealing, cutting into planchettes, adjusting to proper weight, milling, whitening, and finally minting into standard coin. Besides these processes, the checks against loss, the driving power, the amount of work done, value of supplies consumed, and labor expended, with subsidiary details, will also be considered.

WEIGHING-ROOM.—The gold deposits, silver purchases, and retorted amalgam are here received and weighed in the crude state. The weights, in connection with the assay of samples from the deposit-melting room, form a basis for action by the superintendent. This room is on the first floor, at the left of the main entrance, and is in charge of the weigh clerk and assistant weigh clerk, who form the total force. It is included in the general department, which is responsible for all bullion until the latter is formally transmitted to the melter and refiner and accepted by him in the ingot-melting room.

Scales.—The weighing is done on a large pair of Troemner bullion scales, made expressly for the mint. Their capacity is from 0.01 ounce to 6,000 ounces. The center knife-edge is chilled steel on agate bearings, and the knife-edges at each end of the beam are agate on agate. There are no beam riders. Adjustment for wear and tear is secured by filing or removing rings of copper wire, which are hung on pendants.

DEPOSIT-MELTING ROOM.—From the weighing room the crude bullion goes to the deposit-melting room, where it is melted and samples are taken for the assayer. This room is on the first floor at the middle of the south side of the main building, is 18 feet 3 inches by 14 feet 10 inches in size, and is in charge of the deposit melter and his assistant. It is included in the superintendent's special department.

Furnaces.—There are three melting furnaces in the room of the same general type. Two of these have heavy cast-iron shells, frames, and doors, and are lined with fire-brick; they are 18 inches square, inside measurement, 16 inches deep in front, and 30 inches deep at the back, with level grates. The iron sliding doors at the top are sharply inclined, sloping downward from the back. The flue from each is 7 by 9 inches, and leads to the main stack. The smaller furnace is similar in construction, but has a sheet-iron shell. It is 13 inches square, 16 inches deep in front, and 27 inches deep in the rear, and its flue, 5 by 6 inches, leads to a separate small chimney. The grate-bars of each furnace are 1 inch wide, with spaces of five-eighths of an inch intervening.

Fuel.—If several melts are to be made in succession, Lehigh anthracite and nut-pine charcoal mixed are used. For a single melt the fire is made of charcoal only.

Crucibles.—Graphite, French clay, and sand crucibles are used. The series of sizes of graphite crucibles employed includes Nos. 8, 12, 20, 35, 90, 100, and 150. With bullion of the average fineness received, the working capacity of each size is as follows, the weight of the crude charge, exclusive of flux, being given:

	Ounces.
No. 8 crucible	200
No. 12 crucible	250 to 300
No. 20 crucible	400
No. 35 crucible	1,300
No. 90 crucible	2,000 to 2,500
No. 100 crucible	3,500
No. 150 crucible	6,000

These figures are for charges conveniently melted in crucibles of the respective sizes, and do not represent the extreme holding capacity. It should also be observed that the several working capacities are not in direct ratio with the series of designating numbers. The life of graphite crucibles varies from fifteen to twenty melts, according to the character of the bullion treated. If there is much lead in the bullion, the crucibles are more rapidly corroded than if an equivalent percentage of other base metal were present. The stirrers are of the same material as the crucibles—graphite and clay mixed.

Sand crucibles of small size are employed for melting assay grains belonging to each deposit or purchase and are broken after having been once used.

The French crucibles are second-hand ones from the assay department, and are used, merely as a matter of economy, for the same purpose as the sand crucibles. Like the latter, they are destroyed after one firing.

Loss of weight in melting.—With fairly clean bars the loss of weight ranges from five to fourteen one-hundredths of one per cent., and with well-retorted amalgam the loss is from one-half of one per cent. to one per cent.

Fluxes.—The fluxes added to the charge of crude bullion in the melting pots are:

a. Borax, invariably.

b. Sodium bicarbonate, if retorted amalgam is being melted.

c. Potassium nitrate, if iron or carbonaceous matter is present in the bullion.

d. Bone-ash, to thicken the slag so that it may be easily skimmed off.

e. Phosphorus, in quantities not exceeding one-half ounce to a melt of 1,800 ounces, in case the bullion contains much copper.

f. Corrosive sublimate, with bullion containing much lead or antimony.

With fine bars the surface of the melt is protected from the air and volatilization of silver prevented, should the melt become overheated, by sprinkling upon it powdered charcoal sifted through a No. 60 screen.

Molds.—The crude metal sent from the deposit-melting room to the refinery is cast into bars of a peculiar shape, termed "shoe-bars". The shoe-bar mold is a parallelogram slightly contracted at each end and having two transverse ribs or semi-partitions, which rise to a little more than one-half the thickness of the metal cast, thus producing a bar which is deeply indented transversely in two places and can readily be broken into three nearly equal portions, for convenience and greater rapidity in dissolving. The molds are 15 inches long, 3½ inches wide at the center, and 1¾ inches deep (interior dimensions). With bullion containing 40 per cent. in value of gold, the shoe-bars average 200 ounces in weight. The range is from 170 to 220 ounces.

Smaller rectangular molds are used for casting assay bars and small quantities of bullion.

Sampling.—The deposit melter takes two samples of each gold deposit or silver purchase. With gold deposits diagonal corner chips are taken from the bar, the chips together weighing forty one-hundredths of an ounce. If the gold melt is large, making several shoe-bars, a pair of diagonal corner chips are taken from the first and from the last bar of the melt.

With small melts of silver or doré metal two dips are taken directly from the melting pot and granulated, the two granulation samples weighing from twenty to sixty one-hundredths of an ounce. In case of large melts of silver or doré metal granulations are taken from the top and the bottom of the charge by dipping 200 ounces from the melting pot, pouring off all but a few ounces from the dipping cup, and granulating 1½ ounces in cold water. The pair of granulation samples sent to the assayer weigh from twenty to sixty one-hundredths of an ounce.

In each instance a careful system of designating the samples and stamping the corresponding bars is observed, so that the assay determinations in connection with the weights give exact data for the guidance of the superintendent and the melter and refiner.

MELTER AND REFINER'S DEPARTMENT.

The crude bullion, after having been cast into shoe-bars and sampled, is transferred to the melter and refiner's department. From this point the melter and refiner is responsible for all bullion received by him until, after refining and casting into ingots of standard coin metal, it has been transmitted to the coiner's department.

The total force employed in the melter and refiner's department is nine men, including the following officers: melter and refiner, assistant melter and refiner, computing clerk, foreman of the ingot-melting room, and foreman of the refinery.

REFINERY.—The refinery occupies two rooms, 47 feet 4 inches by 23 feet 1½ inches, and 26 feet 10 inches by 18 feet 5 inches in size, on the west side and at the northwest corner of the second story. It is intended to transfer the refinery to the extension when the latter shall have been completed. The force employed is three, consisting of the foreman and two helpers. The work done consists in the following operations: *a*, Parting of gold from silver in doré metal by boiling with sulphuric acid; *b*, "sweetening" the parted gold; *c*, precipitation of silver from the acid solution of argentic sulphate by metallic copper; *d*, "sweetening" the precipitated silver; *e*, disposal of the cupric sulphate solution formed during the process of precipitation; *f*, as an adjunct operation, the manufacture of "silver-cake"; that is, compressed silver precipitate.

First boiling with sulphuric acid.—This is done over four heating furnaces, arranged in two pairs. These are of common brick, lined with fire-brick. The fuel used is yellow pine, in sticks 4 feet long. There are four parting kettles, made of cast iron, 3 feet diameter at the top, 30 inches deep, $\frac{7}{16}$ inch thick at the upper part, and 1¼ inches thick at the bottom. The additional thickness below compensates for the greater exposure there, so that the wastage of iron is uniform. The covers of the parting kettles are also of cast iron, and are conical. They are half an inch thick, and are hung by chains from pulleys and counterpoised.

An essential point in the use of the sulphuric-acid process is that the unparted bars should be of the proper tenor, which by long continued observation is found to be a fineness of from 0.070 to 0.075 in gold, to give the best results in parting. The unparted bullion treated at this mint is very irregular in character, the range being from 0.002 to 0.500 fine in gold. Bullion lately received contained only from 0.002 to 0.020 fine in gold. With this low proportion of gold the latter, on the solution of the doré metal, forms a fine, impalpable powder, which floats on the surface of the acid in the kettle and cannot be perfectly separated from the silver. This defect is corrected by adding gold in the previous melting. Unparted bullion 0.900 fine (in gold and silver) dissolves readily in the shoe-bar shape with or without breaking the bar into its three sections. These bars weigh, as previously stated, from 170 to 220 ounces each. It was formerly the custom when treating Comstock bullion, which, because of its fineness (usually above 0.990), volatilized perceptibly in melting, to protect it by adding a small quantity of very base bullion. Five pounds of lead bullion, containing also some iron, were added per charge. This practice, introduced by the melter and refiner, is said to have worked well. Latterly, however, it has been unnecessary, as the bullion treated has been of lower grade.

The usual charge of unparted bullion is 2,500 ounces to each kettle. The proportion of acid is 4 pounds of sulphuric acid to 1 pound of unparted bullion. One-half of the acid, *i. e.*, 2 pounds to each pound of bullion, is placed in the kettle on charging, and the remainder is added gradually in pitchersful as the silver is taken up. The normal strength of the acid is 62° Baumé, but if the unparted bullion contains much copper a slightly weaker acid is used. The temperature maintained is 650° F., the boiling point of acid of the normal strength. The time occupied in boiling is five hours. At the expiration of this period the fire is drawn and the charge is allowed to cool and settle for two hours. This interval is requisite for an additional reason, namely, that the operator may not suffer from the sulphurous acid fumes.

The method of discharging the kettles is as follows: As much of the parted gold as possible is first ladled out from the bottom; the acid solution of argentic sulphate is then siphoned off, and finally the remainder of the parted gold is removed.

Second boiling of the parted gold.—A further purification of the parted gold is next attained by reboiling it with sulphuric acid in smaller kettles over special furnaces. There are three of these heating furnaces of the same type and dimensions. They have heavy cast-iron shells of octagonal shape externally and are lined with fire-brick. The interior is vertically cylindrical, and is 10 inches in diameter and 15 inches deep. The fuel used is nut-pine charcoal. The three reboiling kettles resemble those employed in the first boiling, but are only 20 inches in diameter at the top and 16 inches deep. The acid is of the same strength, and the time occupied in reboiling is two and a half hours.

"Sweetening" the parted gold after the second boiling.—This consists in repeatedly washing the gold with hot water (not distilled) in a filtering tub. There are six of these filtering vessels. Two are porcelain jars made in Germany, and cost $60 each. They are 20 inches in diameter and 24 inches deep. Four small wooden tubs, lined with sheet lead, are also used; but the porcelain jars are preferable, even at the increased cost, being free from the inconvenience caused by the incrustation of crystallized sulphates, which forms on the interior surfaces of the lead-lined wooden tubs. Porcelain, however, although undoubtedly the best material, appears to have the property, in a very small degree, of reducing silver from the acid solution of argentic sulphate—a point which is undesirable at this stage of the process. This is probably due to the solubility of the glaze of the jars, though the organic matter of the filter may also have the same effect. The straining material is unbleached muslin sheeting. The old filters are burned, the ashes being preserved and returned with the annual clean-up of the mint.

Third boiling and washing of the parted gold.—On the day following the second boiling with sulphuric acid and washing with hot water, the parted gold is subjected to a third boiling with acid and additional washings. The manipulations are a simple repetition of those just described. The gold is now in a state of almost absolute purity.

Avoidance of brittle gold.—Most refineries in which the method of parting by sulphuric acid is adopted produce brittle gold; that is, gold which cannot be rolled safely, and which requires careful annealing before passing the breaking-down rolls, and perhaps may not be sufficiently ductile even after annealing. Much trouble has been experienced at the San Francisco mint from this cause. The presence of the most minute quantity of lead impairs the ductility of gold, but does not affect silver in nearly the same degree. Lead is with difficulty removed when the parting of gold from silver is done by sulphuric acid. To entirely eliminate the lead which may be present a very simple and efficacious expedient has been hit upon, which consists in taking advantage of the difference in specific gravity between gold and lead and the minute subdivision of the particles of the latter. The filtering vessel in which the parted gold is washed with hot water is slightly inclined by the operator, and the lead particles are floated off with the washings into another tub. This plan of simple decantation succeeds so well that at the Carson mint the gold ingots do not require to be annealed before going to the breaking-down rolls.

Disposition of the parted and sweetened gold.—It is dried (without furnace heat) and sent directly to the ingot-melting room. There it is fed into the melting pots very carefully, to avoid loss by sputtering. Where large quantities are treated it is desirable to have the parted and sweetened gold pressed into cakes and dried in a furnace before melting, as is done with the silver at this mint and with both gold and silver at the San Francisco mint. After melting the metal is sampled and cast into bars. It is then known as "mint-fine" gold; that is, gold as near absolute purity as is necessary in the subsequent processes.

Precipitation of silver from the acid solution of argentic sulphate by metallic copper.—In the parting of the gold from the silver of the doré metal the silver is attacked by the acid and appears as a sulphate held in a solution which also contains free sulphuric acid. Besides this solution, there are also the wash-water of decantation and the filtrates formed in sweetening the parted gold. These contain considerable argentic sulphate, and are concentrated by evaporation before reduction. The next step in the process is the recovery of the silver in a metallic state from the acid solution of argentic sulphate. This is effected by precipitation on metallic copper, in four large wooden vats, rectangular in shape and lined with sheet lead. To prevent the escape of the fumes generated during the heating of the liquor the vats are inclosed in vertically-sliding wooden partitions, hung by chains from the ceiling and counterpoised, so that any portion of the interior is readily accessible for inspection or for any of the necessary manipulations. The vats are each 2 feet deep (interior measurement), and the other dimensions are from 6 by 11 to 9 by 12 feet. Laid around the bottom, on the inside of each vat, are three coils of leaden steam-pipes, 2 inches in diameter, fed by live steam from the engine boilers, by which the solution is kept heated to about 180° F. The maintenance of a precise temperature does not appear to be essential to successful precipitation, and any near approximation to the point mentioned is found in practice to be sufficient.

The copper used is from the Lake Superior mines, and is refined at Baltimore, Maryland. Its fineness is something remarkable, being, by assays at the mint, no less than 0.9997, the 0.0003 of impurity remaining being chiefly iron. The form in which the copper has hitherto been employed has been the ordinary 20-pound ingot of commerce as received from the copper-refining works. The melter and refiner, however, has had molds prepared and forwarded to Baltimore for casting the copper in thin slabs, 6 by 12 by 1 inches, with the object of securing a larger precipitating surface in proportion to the weight of metal used, and also with a view to increased convenience in removing the precipitated silver. The charge of copper ingots is 1,000 pounds to each vat. They are laid across the coils of steam-pipes at intervals of 8 inches. The slabs are intended to be placed on the bottom, forming a loose pavement, and also upright along the sides and ends of the vats.

In charging the precipitating vats, after arranging the copper ingots in position, undistilled cold water is poured in through pipes to a depth of from 12 to 14 inches. The acid solution of argentic sulphate is then added, bringing the contents to within about 3 inches of the top of the vat. With the system pursued at this mint the resulting dilution is about 18° Baumé, which is considered the most advantageous strength. After charging, steam is turned on through the leaden coils, and the liquor becomes gradually heated to the desired temperature. The time required for complete precipitation is twenty-four hours of constant heating; but as the mint is ordinarily working during one shift of eight hours only, three days are consumed in this part of the process.

The method of determining whether complete precipitation has been effected is as follows: A small quantity of the acid solution is drawn off, cooled, and poured into a test-tube. A solution of sodium chloride (strength immaterial) is added. A white precipitate of argentic chloride indicates incomplete reduction; but if all the silver has been reduced, no precipitate occurs. These tests are applied from time to time by the operator, and show the progress of the precipitation.

To remove the precipitated silver from the surfaces of the copper ingots the latter are scraped twice a day with long-handled wooden spatulas. No especial care is taken to remove by itself all the silver recovered from each separate charge, as ultimately all is saved, and there is no necessity for segregating the results of each operation. Indeed, to attempt to do so would be to entail much additional labor, resulting in insignificant advantages, as the system of dividing the responsibility and accountability serves as an effectual check upon loss or error from this source.

The copper ingots last about two weeks, the gradual wastage being made good by the addition of fresh quantities of copper. Each residual ingot averages 8 ounces in weight. Thus the whole of the original charge

of copper placed in a vat at any one time may be assumed (disregarding the fresh ingots added) to have been diminished in weight from 1,000 to 25 pounds; and the average amount of copper converted into cupric sulphate being taken as 19 pounds 8 ounces for each ingot, the whole amount of copper of the original charge thus converted into sulphate is 975 pounds, or 97½ per cent. The residual copper, now in the form of small irregular nuggets, is washed upon removal from the vat to detach any adhering silver, and is sent to the ingot-melting room, to be used in alloying the mint-fine gold and silver to the standard coin fineness.

Sweetening the precipitated silver.—This operation is analogous to the method of purifying the parted gold, and consists in repeatedly washing with hot water the precipitated silver collected from the faces of the copper ingots. The mountain water from the mint service-pipes is very pure, and contains no chlorides. Were the latter present, they would necessitate a distillation of the water to prevent the formation of argentic chloride. There are four wooden filtering vats lined with sheet-lead. The internal measurements are: Diameter at top, 28 inches; diameter at bottom, 24 inches; depth, 24 inches. The filters are of unbleached muslin sheeting. When old, they are burned, and the ashes are returned with the sweepings, etc., at the close of the fiscal year.

Disposition of the cupric sulphate solution.—As the precipitation of metallic silver upon the copper ingots proceeds sulphate of copper is formed, replacing the sulphate of silver in the solution. After all the silver has been thrown down, the solution of cupric sulphate is siphoned out from the precipitating vats and is drawn through leaden pipes into a lead-lined tank outside the building, whence it is removed by the contractors. It is used by the Lyon Mill and Mining Company at their works at Dayton in the amalgamation of tailings. The contract strength is 20° Baumé, and the price paid in the census year was at the rate of 17 cents per pound for each pound of copper used in the mint refinery.

Prevention of loss of precious metal in the refinery.—The floor is covered with sheet lead throughout and is mopped several times every day. Whenever a portion of any solution is spilled, it is at once wiped up. The mop-cloths are finally burned, and the ashes are returned with the general clean-up of the mint at the close of the fiscal year. All savings of this kind are credited, according to assay, to the melter and refiner in making up the annual accounts. The savings also include slags, sweepings, furnace-ashes, flue-dust, burned filters, old cupels, broken crucibles and stirrers, etc.

Manufacture of silver-cake.—The wet and loose silver, after sweetening, is squeezed into consistent shape by powerful hydraulic presses, and is then dried in a special furnace. Two of these presses are used. The pressure exerted is 40 tons to the whole area of the plunger face. The plunger is 12 inches in diameter, and the collar, which fits closely on the plunger, is 12 inches deep. The weight of a single pressed cake before drying is 1,100 to 1,200 ounces, and its volume is about one-quarter of that of the unpressed charge.

Drying the pressed silver-cake.—One drying furnace is used. It is 34 inches wide, 13 inches high, and 8 feet long, and has a flat roof. The lining is of fire-brick, and the frames and doors are of cast iron. The grate area is 2 by 8 feet, and the grate-bars are 1 inch wide and five-eighths of an inch apart. The fuel used is yellow pine, in 4-foot sticks. The cakes are charged in pans, supported by six longitudinal bars, 1¼ inches wide, with intervening spaces of 3⅝ inches. When completely dried, but not fused, the cakes are sent to the ingot-melting room and melted. The product is then known as mint-fine silver.

THE INGOT-MELTING ROOM.—This room is on the first floor at the rear, adjoining the rolling-room, and is 23 feet 1½ inches by 22 feet 8 inches in size. It belongs to the melter and refiner's department, and is in charge of a foreman, with three helpers. The length of shift is eight hours. The work done here is: *a*, Melting the silver-cake and the sweetened gold separately into mint-fine metal; *b*, preparation of standard coin alloy and remelting of clippings from the cutting room; *c*, casting the alloy and the remelt into ingots; and *d*, cleaning the ingots and dressing them into shape.

In this room there are five furnaces, all alike. They have heavy cast-iron shells, lined with fire-brick, and are 16 by 16½ inches in area, 17½ inches deep in front, and 20 inches deep in rear, measured from the grate to the bottom of the flue. The flues are 6 by 8 inches, and lead to the main stack. The doors are of cast iron, steeply inclined toward the front. Lehigh anthracite is used as fuel. The crucibles and stirrers are of graphite and clay mixed, the sizes of crucibles used being Nos. 45, 60, and 90. No. 12 Dixon crucibles are employed for dipping cups. The flux is borax, and sometimes also niter, sal ammoniac, bone-ash, and powdered charcoal. A melt of silver usually consists of from 5,000 to 6,000 ounces, but a melt of gold is smaller, and is variable.

System of sampling mint-fine silver.—A cupful of about 200 ounces is taken from the top of the melt. Of this quantity all but 5 or 6 ounces is poured back into the crucible, and the remainder is cast into a small assay bar, stamped with the assay number of the melt, and also numbered "1", to indicate that it is the top sample. When the large pot is nearly empty this process is repeated, and a second assay bar is obtained, which is stamped as before, but numbered "2", to denote that it is the bottom sample.

System of sampling mint-fine gold.—A similar method is practiced with gold, except that the assay bars cast are 10 ounces in weight.

Molds.—The molds are of clamped cast-iron, and for gold the series consists of one size each for double-eagle, eagle, half-eagle, and quarter-eagle ingots. Quarter-eagles are not coined at this mint, though the necessary molds, dies, etc., are on hand. For silver ingots three sizes of molds are used: one for quarters, one for halves,

and one for dimes and standard or trade dollars. The dollar mold produces ingots from which strips for punching a double row of dimes are rolled. The total stock embraced 135 ingot molds, as follows: Double-eagle, 6; eagle, 10; half-eagle, 10; quarter-eagle, 10; dollar and dime, 36; half-dollar, 36; quarter-dollar, 27. The duration of the molds is indefinite. They are said to become better as they grow older.

The ingots are cooled and cleaned by being plunged into a bath of cold water, slightly acidulated with sulphuric acid, in the proportion of 5 ounces of the commercial acid to 25 gallons of water.

Manufacture of standard gold ingots.—On the report of the assayer as to the fineness of the samples of mint-fine gold (which average 0.997 gold and 0.003 silver) the melter and refiner bases his computation as to the amount of copper required to reduce a given weight of mint-fine gold to the coin standard. The law prescribes that the proportion of copper shall not be less than 0.090. After placing into the crucible the proper amounts of gold and copper, clippings from the cutting-room may be added to complete the charge. The average weight of gold-ingot melts is 3,000 ounces. In sampling the coin ingots a center chip is taken from the heads of the first and last ingots of the melt, and from the assays of these samples the assayer certifies to the alloy being of the proper proportions.

Manufacture of standard silver ingots.—The calculation for copper is similarly based on the assayer's report as to the fineness of the mint-fine silver. The proper amounts of silver and copper having been placed in the crucible, the charge may be filled out with clippings from standard silver strips, as in the case of the gold melts. The average weight of the silver-ingot melt is 1,800 ounces. Granulations are taken from the top and bottom of each melt, the two samples together weighing about 0.30 ounce.

Legal tolerance.—The legal tolerance is the slight variation allowed by the law from the absolute standard. For gold this margin is 0.0015 each way from the standard; that is, the coin may contain from 0.8985 to 0.9015 gold. For silver the allowance is 0.003 each way from the standard, or, in other words, the coin may legally vary from 0.897 to 0.903 in silver.

Actual working tolerance.—The mint regulations prescribe much greater accuracy than is required by the law. In mint practice the gold ingots are not allowed to vary more than 0.0005 from the standard, and the silver ingots are kept within a range of 0.0015. Thus the gold ingots actually only vary from 0.8995 to 0.9005, and the silver from 0.8985 to 0.9015 in fine metal.

Liquation of silver in standard ingots.—In cooling there is a partial segregation of silver toward the center of the ingot, which results in making the center richer than the edges. It is found that the central portion of a rolled strip of standard silver prepared from such an ingot (the molecules during the rolling process maintaining the same relative positions to each other laterally that they had in the ingot) may sometimes be from 0.0005 to 0.001 finer than the edges of the same strip. This variation differs with the character of the strips; that is, for which sized coin they are intended. The planchettes are therefore slightly finer than the clippings, the greater bulk of the latter being from the edges of the strip, while the planchettes contain proportionally more of the central part. A slight allowance has sometimes been made to offset this irregularity. The alloy of gold and copper does not act in the same way, being more stable, and if there is a similar liquation it is in an imperceptible degree.

Dressing the ingots.—The ends of the ingots are squared by a clipping machine, the invention of the late John A. Eckfelt, of the San Francisco mint. This is a very compact and convenient machine, consisting of a vertically-sliding steel jaw in combination with a fixed steel lower jaw, the driving machinery being inclosed in an upright frame or post. The ingots are then clamped in a vise and the rough edges dressed down by a 14-inch bastard file. After trimming, the ingots are sent to the rolling-room. The standard silver ingots weigh from 48 to 50 ounces each. The gold ingots for eagles weigh 69 ounces, and those for half-eagles 44 ounces.

The floor of the ingot-melting room is covered by hexagonal cast-iron gratings, easily removable when the room is swept. Wherever practicable, as for pails, tongs, etc., the utensils here used are of copper. Iron discolors the silver ingots.

A settlement of the standard ingots is made weekly. Bullion is received in the melter and refiner's department on the 1st and 15th of each month. All bullion is reweighed on receipt, in addition to the tally made by the melter and refiner or his assistant, when it is weighed out and delivered by the weigh clerk.

COINER'S DEPARTMENT.

ROLLING-ROOM.—The ingots of standard coin metal, prepared in the melter and refiner's department, are next taken to the rolling-room, where they are rolled into strips of approximately the proper thickness, as a preparatory step toward punching out the planchettes. This room is on the west side of the first floor, adjoining the ingot-melting room, and is in charge of the roller. The force here employed is three men.

Rolls.—Two pairs of heavy rolls, made of chilled cast steel, are used. One pair, called the breaking-down rolls, first reduce the ingots roughly; the second pair then still further reduce the thickness. The draw-bench in the cutting-room is also fitted with smaller finishing rolls. The rolling-machines were made in Philadelphia; one pair of the heavy rolls were furnished by the Krupp steel works at Essen, Rhenish Prussia, and the others were made in Pittsburgh. The rolls of American make are found to be perfectly satisfactory. Those in the rolling-room

each have a face 10 inches long, and are 8 inches in diameter. The trunnions are cast solid with the roller portion, and are 12 inches long and 6 inches in diameter. The journal-boxes are of brass, the lower half being provided with two gibs of babbitt-metal about 90° apart, each 1½ inches face, and extending the full length of the bearing surface. When new, these babbitt strips project very slightly above the brass face. The rolls are driven at a speed of seventy-eight to eighty revolutions per minute. The limit of play is five-eighths of an inch, and the adjustment is effected by screw hand-wheels. A clock-gauge indicates the distance between the roll-faces with great precision.

Power.—The power required to drive a single pair of rolls varies from 8 to 40 horse-power, depending upon the character of the work done. When first breaking down the fresh ingots the 30 horse-power 10-inch belts often slip, although they are carried on leather-faced band-wheels. In the final rolling much less power is required. Each roll has its own pulley, the upper and the lower roll being thus driven independently at the same speed in opposite directions. The band-wheels are 5 feet in diameter, with 10 inches face, and weigh 250 pounds each. They are faced with leather, which is riveted on.

Rolling.—An ingot for making standard dollars is 12½ inches long, 1½ inches wide, and $\frac{7}{16}$ inch thick before passing through the breaking-down rolls. It is reduced in thickness to nearly that of the coin, and is drawn out to a length of 3 feet 1 inch; but the increase of width in the finished strip, as compared with that of the ingot, is almost imperceptible, although it is perfectly free to expand laterally. The strips are rolled and re-rolled as often as may be necessary until they assume the proper thinness. To prevent any flexure of the strips the rolls are provided on the discharge side with loose, flat, hopper-shaped guides, an improvement designed by the machinist of this mint. Only lateral guides are attached to the feed-side of the machines.

Testing the thickness of the rolled strips.—A power cutting-press, similar to those in the cutting-room, is used as a test-punch. It is fitted with adjustable dies and collars for the different sizes of planchettes, and with it trial planchettes are struck from the strips as the rolling progresses. These are tested on a small pair of Troemner scales in the room. The roller is allowed a margin of 0.06 per cent. in excess of the standard weight, but of course must not roll the strips too thin.

Shearing the rolled strips.—For convenience in subsequent work the long strips are each cut into two equal lengths. This is done by a shearing-machine, which consists in a movable upper and a fixed lower jaw of chilled steel. The jaws are 4 inches long, and have an extreme bite of three-quarters of an inch at the outer end.

ANNEALING ROOM.—After having been sheared, the strips are taken to the annealing room, which is in the basement, adjoining the cutting-room, and is in charge of the annealer and his assistant. The work here done is to anneal the strips of gold and silver standard coin metal after their preliminary reduction by the large rolls and preparatory to their finishing treatment on the draw-bench of the cutting-room. The object is to prevent any brittleness in the metal, which would seriously interfere with the subsequent operations, particularly that of coining.

Furnaces.—There are two annealing furnaces of the same size and character. They have heavy cast-iron frames and doors, and are lined with Santa Cruz fire-brick. The doors are 12½ inches wide and 11 inches high. The fire-chamber is 18 inches high, and the grate area is 14 inches by 5 feet 8 inches. The grate bars are arranged across the furnace hearth, and are 1½ inches wide, with 1-inch spaces. Split yellow pine, in 4-foot sticks, is used as fuel. When the mint is running steadily the furnaces are used daily, and consume 1½ cords per week.

Annealing canisters.—The strips are protected by cylindrical copper tubes, capable of holding several strips each. These canisters are closed at one end and fitted at the other with copper covers, which are luted on with fire-clay. For gold strips they are 3 feet 6 inches long, 4½ inches internal diameter, and $\frac{3}{16}$ inch thick, and for silver strips 3 feet 2 inches long, 4½ inches internal diameter, and $\frac{1}{8}$ inch thick. Two canisters are charged in a furnace together, and are heated a dull red for 40 minutes. The length of exposure to the heat is the same, whether the strips are gold or silver. The average life of the canisters when in constant use is two months; there are twenty-seven in stock.

Cooling the heated strips.—On removal from the furnace the strips are gradually cooled in warm water. This is done in two annealing vats, made of wood and lined with sheet copper and provided with hinged wooden covers, also copper-lined. They are rectangular in shape, 4 feet 6 inches long, 18 inches deep, and 2 feet wide. Steam-pipes rest upon the bottoms of the vats, through which live steam from the engine boilers passes, raising the temperature of the water (before the introduction of the strips) to 180° F. The time occupied in cooling the strips to below the boiling point is ten minutes, making the whole duration of the annealing process fifty minutes.

CUTTING-ROOM.—After annealing, the strips are transferred to the cutting-room. This room is at the southeast corner of the basement, adjoining the annealing-room, is 16 feet square, and is in charge of the cutter. The total force is three men. The work done here is: *a*, The final dressing of the rolled strips by stubbing their ends and reducing them to standard thickness on a draw-bench; *b*, cutting and weighing trial planchettes; and, *c*, cutting out the planchettes for coining.

Stubbing.—This consists in pinching one end of each strip so that it can be fed through the rolls of the draw-bench and be seized by the dogs or clutches of that machine. The stubbing apparatus consists of a pair of small chilled steel rolls, 3⅛ inches diameter and 2¾ inches face, the upper roll being a plain cylinder, but the lower a cylinder of the same shape, except that its periphery is beveled with four flat facets, each 1½ inches wide. These stubbing-rolls are adjusted by hand-screws to regulate the distance between the faces according to the character

of the strip operated on; that is, whether it is intended for dollars, for halves, or for other coins. The length of the stubbed portion of a strip is 2 inches. The strips are "doped" before treatment, the silver ones by dipping in tallow and the gold ones by being beeswaxed.

Drawing the stubbed strips.—The draw-bench is similar in principle to those used in wire-works, but is designed for flat drawing. It has two small adjustable steel rolls, set vertically and revolving freely in opposite directions. The stubbed end of the strip is fed by hand between these rolls, when it is seized on the discharge side of the rolls by the draw-dogs and pulled through. The dogs are clamped by a treadle, worked by the operator. The draw-bench thus completes the rolling of the strips which the large rolls of the rolling-room began.

Punching the planchettes.—Two cutting-presses are used. These are of similar size and pattern, and run at the rate of two hundred and eighty strokes per minute while cutting, but there is a loss of time in feeding the successive strips. Power is applied by means of eccentrics on a counter-shaft under the presses. The feed is by hand, and is regulated by a fixed gauge. Double dies, the invention of the coiner, Levi Dague, are used in cutting out the dime planchettes. They punch two planchettes, side by side, from the strip at a single stroke. A considerable saving in time is effected in this way; but for larger coins it would be impracticable to use double dies, unless with very powerful machinery.

Testing the planchettes.—A trial blank is taken from the middle and from each end of every third strip, and is tested on a pair of Troemner assay scales by the cutter's weigher. The power required in the cutting-room is about 10 horse-power.

The planchettes form about 60 per cent. of the original weight of the strips, the remainder being clippings. These clippings, as already stated, are returned to the ingot-melting room, and are there used in filling up the crucibles in which the standard alloys are melted. The planchettes themselves are washed in hot water with potash and soap, dried in pans, and then sent to the adjusting rooms.

ADJUSTING ROOMS.—Adjusting consists in filing the planchettes sent from the cutting-presses, if necessary, so that they are brought to the standard weight or within the limit of working tolerance. This work is done by eight women under the supervision of a forewoman. Each adjuster has a small pair of Troemner scales, upon which the planchettes are tested. If a planchette is found to weigh more than the working tolerance allows, it is filed on the edge by rolling it between the thumb and fingers lengthwise over a 10-inch bastard file, thus reducing its circumference uniformly. If its weight is already within the prescribed limits, it is passed without adjusting; if too light, it is condemned. The legal tolerance in weight is: for double-eagles and eagles, $\frac{1}{2}$ grain; for half- and quarter-eagles, $\frac{1}{4}$ grain; for standard dollars, $1\frac{1}{2}$ grains. The work is kept well within these limits. Each gold planchette, after adjusting, is reweighed separately by the forewoman, and all the adjusted pieces are again weighed, by drafts, in the coiner's office. After leaving the adjusting rooms and being checked in the coiner's office the planchettes are milled in the press-room, rechecked, and sent to the whitening-room.

WHITENING-ROOM.—This is on the first floor, at the middle of the north end of the building. The manipulations conducted here consist in: *a*, Cleansing the milled planchettes (at this stage called "blanks") in a hot alkaline bath; *b*, rinsing with hot water; *c*, heating; *d*, immersion in acidulated bath; *e*, rinsing in cold water; *f*, partial drying in riddles with sawdust; *g*, final drying in closed pans. For convenience and for economy of fuel these operations are performed only every other day, except when the mint is running at full capacity.

Washing the blanks in the alkaline bath.—The vessel used is a stout copper pan, 30 inches in diameter at the top and 9 inches deep. The charge is 1,000 blanks of the dollar size, or a corresponding amount of blanks for other denominations. Both gold and silver are treated alike at this stage. The bath is a strong hot-water suds of soda and bar soap, and its object is to remove the grease. The time occupied in this washing is about five minutes for each draft of blanks.

Rinsing after the alkaline wash.—The rinsing vat is a wooden tub, 30 inches in diameter and 18 inches deep, lined with sheet lead and having a protecting rim and a partial lining of sheet copper at the top. In this the blanks are thoroughly rinsed with undistilled boiling water.

Heating the blanks.—At the next stage of the process the blanks, after having been washed in the alkaline bath and rinsed, are heated to a cherry red in suitable furnaces. There are two of these furnaces, each 2 feet square, made of common brick and lined with fire-brick. The frames and doors are of cast iron. The fuel is yellow pine. The silver blanks are charged in open earthenware pans, and are exposed to the heat for fifteen minutes. Gold blanks are charged in rectangular cast-iron canisters hermetically closed and luted with potters' clay, and are heated twenty minutes.

Pickling the heated blanks.—The heated blanks are next subjected to an acidulated hot bath. For gold blanks this is a pickle composed of 4 ounces of commercial nitric acid to 16 gallons of undistilled water, and for silver blanks the bath contains from $4\frac{1}{2}$ to 5 ounces of sulphuric acid (62° Baumé) to 16 gallons of water. The pickling process occupies five minutes. A single tub is used for both the nitric acid and the sulphuric acid baths. It is 30 inches in diameter and 16 inches deep, and is of unprotected wood. It is proposed to substitute a lead-lined wooden vat for the sulphuric acid pickle. The object of pickling the blanks is to remove oxidation and discoloration due to the canister copper, and, in effect, a slight proportion of the copper of the alloy is removed from the faces of the blanks, thus brightening the surface of the coin. The loss of metal in this process is 0.05 ounce in 1,000 ounces of gold blanks and 0.10 ounce in 1,000 ounces of silver blanks.

Rinsing after pickling.—The blanks are now rinsed with undistilled cold water in a plain wooden tub, 18 inches deep and 30 inches in diameter.

Partial drying with sawdust.—After rinsing, the blanks are placed in a coarse copper riddle and are partially dried by being shaken with sawdust. For this purpose basswood sawdust, brought from Philadelphia, is employed.

Final drying in closed pans.—The drying chambers are of wood, rectangular in shape, 33 inches by 6 feet, and 10 inches deep, and provided with loosely fitting flat covers. They are lined throughout, covers included, with sheet copper, and are heated to 180° F. by means of a steam coil fed with live steam from the engine boilers and arranged under each pan. In fifteen minutes the blanks are thoroughly dry and are now ready for coining.

PRESS-ROOM.—The room containing the milling machines and coining presses is on the first floor at the northeast corner. Here the adjusted planchettes are milled into blanks, and the blanks (after whitening) are made into coin. The blanks are fed to the machines and presses by women.

Milling machines.—These turn up the edges of the blanks, making them perfectly true. Three are in use: One for standard and trade dollars, requiring one horse-power each; one for subsidiary silver coins, requiring half a horse-power; and one for gold coins, requiring one horse-power.

Coining presses.—No. 1 coins double-eagles, standard dollars, and trade dollars. This model is said to be the most powerful coining press in existence, and is known as the Ajax. The one in the Carson mint was exhibited at the Philadelphia exposition. Its pressure is rated at 152 tons, but employés of the San Francisco mint rate the pressure of the Ajax type at 200 tons. The working speed is from 85 to 98 pieces per minute. The power required is only 5 horse-power, and the adjustment is so perfect that a coin may be struck by simply turning the fly-wheel by hand.

No. 2 press is of medium size, and is designed for coining eagles, half-eagles, standard and trade dollars, halves, or dimes. It strikes 95 pieces per minute at the usual working speed, and requires nearly 5 horse-power.

No. 3, the smallest press, is intended for coining quarter-eagles, quarter-dollars, and dimes, but is not in use, as the mint does not make these denominations. Its capacity is 140 pieces per minute, and it requires 2 horse-power.

The total press capacity of the mint is one-third in excess of that of the preparatory appliances. Their arches are of the best Scotch pig cast iron, that of the Ajax weighing over 7,000 pounds, that of No. 2 press over 5,000 pounds, and the arch of No. 3 about 3,500 pounds. The levers are of brass. The original arch of No. 2 cracked on the line of a bolt hole while coining standard dollars and was replaced by a casting 1½ inches thicker. All the presses run with beautiful smoothness.

A 10-inch emery wheel, ¾-inch face, is used to dress the bottoms of the dies evenly. It is driven at a speed of eight hundred revolutions per minute by a rubber friction roller in contact with the fly-wheel of the small coining press.

SIZE AND WEIGHT OF UNITED STATES GOLD AND SILVER COINS.

Denomination.	SIZE.		WEIGHT.	
	Diameter, in twentieths of an inch.	Thickness, in thousandths of an inch.	Grains.	Troy ounces.
Double-eagle	27	0.077	516	1.075
Eagle	21	0.060	258	0.5375
Half-eagle	17	0.046	129	0.26875
Quarter-eagle	14	0.034	64½	0.134375
Standard dollar	30	0.082	412½	0.859375
Trade dollar	30	0.082	420	0.8750
Half-dollar	24	0.057	192.9	0.401875
Quarter-dollar	19	0.045	96.45	0.200937
Dime	14	0.032	38.58	0.080375
Half-dime	12	0.023	19.29	0.0401875

The specific gravity of United States gold coins of 0.900 fine standard is 17.165.

ASSAYER'S DEPARTMENT.

The assayer's department is on the second floor, at the south end of the main building, and extends from the front to the rear. It comprises five rooms—office, laboratory, fire-assay room, volumetric test-room, and charcoal storeroom. The force consists of the assayer, assistant assayer, humid assayer, cupeller and dissolver, and clerk.

Assay scales.—Two fine Oertling balances, costing $350 each, are in use. The working delicacy of these scales is $\frac{1}{10}$ milligram, but by subdividing the beam-rider spaces a delicacy of $\frac{1}{40}$ milligram is attainable.

Sampling.—The system of sampling the bullion in the deposit-melting room has already been described. In sampling the assay bars of mint-fine metal from the ingot-melting room the practice is as follows: For gold, one inside chip, averaging 0.35 ounce in weight, is taken from each of the 10-ounce top and bottom assay bars (which have been stamped "1" and "2" respectively); for silver, one inside chip, averaging also 0.35 ounce, is taken from each 6- or 8-ounce assay bar.

System of assaying.—It is hardly necessary for the purposes of this chapter to enter into details familiar to most readers. The fire assay is used: *a*, In testing purchases and deposits; *b*, mint-fine gold; *c*, standard gold ingots; and occasionally, *d*, as a check upon the humid or volumetric method.

The volumetric system of Gay-Lussac (precipitation by a normal solution of sodium chloride) is employed with (*a*) mint-fine silver and (*b*) standard silver ingots. As applied at the Carson mint, the humid method gives $\frac{1}{10}$ of 0.001 in fineness, and the assayer's reports are in tenths of thousandths. The readings in the volumetric test-room are compared against a black screen, which is hung in front of the window.

Apparatus and machines.—The assay plant includes:

A muffle furnace in the fire-assay room. It has a soapstone front and three muffle doors.

An ore-assay furnace in the same room, 13 by 13 inches, and similar to the small furnace in the deposit-melting room. This furnace holds six assay crucibles.

Sand bath in the same room.

A condensing apparatus, consisting of a steam-coil condenser, having a capacity of 100 gallons in eight hours. As before stated, the water supplied to the mint is very pure, being from mountain streams. It contains hardly a trace of chlorine, but has a little lime, and for ordinary purposes does not need to be distilled. The main use of the condenser is to supply water for the humid assay of silver.

Two pairs of small power rolls made of chilled cast steel, one of which is used in rolling assay lead and the other for gold and silver. These are alike, and are 2½ inches in diameter and 4 inches face.

A shaking machine for agitating the precipitating bottles used in the humid assay. It holds twelve precipitating bottles. The vibrations are vertical and extend 2½ inches, and the speed is two hundred and forty strokes per minute. This machine is driven by a rawhide band from a 4-horse power engine.

MISCELLANEOUS.

LOSS OF PRECIOUS METALS.—*Flue-dust.*—The main stack of the mint is of common brick, 80 feet high, and has a single plain flue, which is circular in cross-section and 4 feet diameter. The addition of dust-chambers would effect a saving which would undoubtedly cover their expense. At the foot of the stack is a man-way, for access in cleaning, provided with an iron door. It has been the custom to clean out the flue at the close of each fiscal year. In 1880 no such clean-up was made, as the mint had been executing comparatively little work. The stack clean-up in June, 1879, produced 2 ounces of fine gold and 80 ounces of fine silver. This was less than the average for the preceding years. The amount of gold and silver which actually escapes through the stack cannot be accurately determined.

Loss in melting and refining.—The greater part of the total loss occurs in these operations. Each particle of metal is melted at least three times, exclusive of the clippings, which undergo a constant cycle of manipulations, so that it is possible to conceive of certain particles being remelted indefinitely. At each melting there is a small loss by volatilization, which it is endeavored to avoid by covering the surface of the melt with powdered charcoal.

The legal tolerance of wastage is 1½ ounces of silver in every 1,000 ounces of fine metal treated and 1 ounce of gold in each 1,000 ounces of fine gold handled. The actual loss in the melter and refiner's department, as compared with the legal allowance on the quantity of bullion refined, is shown in the following table, from which it appears that the working results have been kept well within the authorized limits:

LOSSES OF GOLD AND SILVER IN MELTING AND REFINING AT THE CARSON MINT.

Period.	GOLD.		SILVER.	
	Legal tolerance.	Actual loss.	Legal tolerance.	Actual loss.
	Ounces.	*Ounces.*	*Ounces.*	*Ounces.*
Fiscal year ending June 30, 1878	90	18	6,000	700
Fiscal year ending June 30, 1879	39	33	4,500	330
Fiscal year ending June 30, 1880	35	6	1,304	135

The total wastage during the fiscal year ending June 30, 1880, at this mint was as follows:

Melter and refiner's gold wastage	$124 50
Coiner's gold wastage	45 51
Melter and refiner's silver wastage	157 47
Coiner's silver wastage	149 18
Total	476 66

MOTIVE POWER.—*Boilers.*—The boiler-room is on the ground floor of the extension, in the rear of the main building. There are two horizontal, plain flue boilers, each 16 feet long and 54 inches in diameter, and having 52 flues 3½ inches in diameter. The total grate area is 38 square feet, the grate being 9 feet 6 inches across the front of

the pair of boilers and 4 feet deep. The grate bars are 8 inches wide, 4 feet long, and three-quarters of an inch thick, and are stiffened with vertical ribs 6 inches deep. The bars run lengthwise with the boilers, and are perforated with holes half an inch square at the top and five-eighths of an inch square at the under surface, these openings being arranged in rows of three lines of holes half an inch apart and 2 inches between each set of three lines. The fuel is yellow pine, in 4-foot sticks, and the consumption of wood is 1½ cords per eight-hour shift. Feed-water is supplied at 180° F. The pressure averages 70 pounds. Steam is sent from these boilers to the main engine and the small engine and condensing apparatus in the assay department, and is also used in the refinery for heating the precipitating vats in the whitening and annealing rooms and for various purposes.

Engines.—The main engine is of the Gardiner slide-valve type. The cylinder is 14 inches in diameter, with 36-inch stroke. The speed is 52 strokes per minute when the presses are running, and 54 strokes with the rolls alone. The working horse-power ranges from 45 to 75, according to the number of machines driven. The fly-wheel is 12 feet in diameter, and is in eight sections. The rim is 8 inches deep and 3⅜ inches wide; its total weight is 5,206 pounds. The main shaft is 8 inches diameter and 8 feet long; the driving pulley 8 feet diameter and 16 inches face. The main driving belt is known as a "75 horse-power". There are fourteen principal counter-shafts.

The small vertical engine in the assay department has a 4- by 8-inch cylinder, and is rated at 4 horse-power. It drives two pairs of assay rolls and the shaking machine used in the humid test, and runs from three to seven hours per day.

TEMPERING DIES AND COLLARS.—The dies and collars of the coining presses require a high temper, which is attained in this mint by careful heating in a special furnace and instantaneous cooling in an apparatus of peculiar construction. The furnace has a cast-iron shell lined with fire-brick, is 24 by 20 inches, and has a grate area 15 inches square. The fuel is nut-pine charcoal. Four dies or collars are heated simultaneously, the length of exposure being one hour. The quenching vat is made of $\frac{3}{16}$-inch wrought iron, is 26½ inches long, 18 inches wide, and 18 inches deep, and has a close-fitting hinged iron cover. The dies or collars are not immersed directly in water, but are placed in a brass holder, through which, after the article to be tempered has been clamped in place, a powerful stream of cold water is passed. These holders are of two sizes, one for quenching dies, and a larger size for collars. They are made in two parts, with a screw-clamp for securing the die or collar, and are provided with a screw-socket, which fits upon the threaded head of a water-pipe. The mode of application is as follows: The heated die or collar having been clamped in the machine, the latter is screwed upon the pipe and the lid of the vat is closed, these operations being performed in a moment. The stream is then turned on, and plays upon the face of the die or collar, rapidly and uniformly chilling the steel by the constant impact of fresh portions of the water. The pipe is 2½ inches in diameter, and the head is 100 pounds per square inch. The water is allowed to run three minutes, at the expiration of which time the holder is unscrewed and the tempered die or collar is removed and dried.

DRESSING THE ROLLS.—The grinding room is in the front part of the basement. Here the rolls are ground true when their faces have become irregularly worn. This is done by means of a grinding lathe, which has a solid emery wheel 22 inches in diameter and 1¼ inches face and runs at a speed of eight hundred revolutions per minute. The machine requires 8 horse-power. A very light pressure is used. The dressing was formerly done by a grindstone, which gave equally good results, but worked very slowly. The emery wheel accomplishes in one and a half hours' work what requires twenty-four hours if done by a common grindstone.

CHILI MILLS.—The mint contains two Chili mills. Of these the smaller is used by the deposit melter in grinding iron slags, broken crucibles, etc. The larger, in the sweeps room, is used to grind all the miscellaneous savings containing gold and silver, including furnace clinkers, the worn-out melting-pots, and similar matter.

The deposit melter's mill is in an alcove of the basement near the center of the main building. The two cast-iron grinding rollers are 18 inches in diameter and 6½ inches face. The pan is also of cast iron, and is 28½ inches in diameter, with a rim 4 inches high. The rim is 1 inch thick at the bottom and half an inch thick at the top. The die is 1¼ inches thick. The pan makes twenty-three or twenty-four revolutions per minute, and requires about 3 horse-power.

The larger mill is of the same pattern. Its rollers are 28 inches in diameter and 12 inches face. The pan is 4 feet 5 inches in diameter, and has a 6-inch rim, which is seven-eighths of an inch thick at the top and 1 inch thick at the bottom. The die is 2 inches thick. The speed is twenty revolutions per minute, requiring 12 horse-power.

The ground sweepings are sifted through a No. 60 screen and carefully mixed and sampled. The melter and refiner is credited with the assay value of the savings. The latter average $200 per ton, and are sold to the Sacramento or Salt Lake smelters.

SCALES.—Four pairs of Troemner bullion scales are in use—one in the weighing room, where the crude bullion is received, having a capacity of 6,000 ounces; one pair in the cashier's office; one in the melter and refiner's office, and one in the coiner's office—each of which has a capacity of 2,000 ounces.

Besides the two Oertling assay balances already mentioned there are in the mint thirteen small balances, nine in the adjusting rooms, and one each in the rolling-room, cutting-room, melter and refiner's office, and coiner's office.

ELEVATOR.—An elevator runs from the floor of the basement to the second story, and is operated by a worm and screw on a counter-shaft from the line-shaft. The capacity is one ton, the heaviest load being the sulphuric acid tank, which, when full, weighs 1,900 pounds.

DEPOSITS AND PURCHASES OF GOLD AND SILVER BULLION AT THE CARSON MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Gold	$368,174 51
Silver	622,291 88
Total	990,466 39

This was exclusively bullion of domestic production.

DEPOSITS AND PURCHASES OF GOLD AND SILVER OF DOMESTIC PRODUCTION AT THE CARSON MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Source.	Gold.	Silver.	Total.
Arizona	$367 91	$12 58	$380 49
California	25,380 85	19,331 05	44,720 90
Idaho	1,874 64	24 72	1,899 36
Nevada	340,837 45	602,920 00	943,757 45
Utah	204 66	3 53	208 19
Total	368,174 51	622,291 88	990,466 39

COINAGE EXECUTED AT THE CARSON MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880. (a)

Denomination.	Pieces.	Value.
GOLD.		
Double-eagles	1,773	$35,460
Eagles	4,472	44,720
Half-eagles	33,322	166,610
Total gold	39,567	246,790
SILVER.		
Dollars	408,000	408,000
Total coinage	447,567	654,790

a The stock of bullion having become reduced, and the Treasury Department being unable to purchase a supply sufficient to keep the mint running, coinage operations were temporarily suspended from November 1, 1879, to May 1, 1880.

COST OF SUPPLIES AND MISCELLANEOUS EXPENSES AT THE CARSON MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Acids, sulphuric and nitric	$992 95
Chemicals	137 51
Carpets	203 22
Crucibles, covers, dipping cups, etc	132 45
Castings	385 28
Charcoal	2,010 77
Dry and woolen goods	631 78
Drayage	51 50
Freight and express charges	50 26
Furniture	14 00
Gloves and mittens (buckskin and rubber)	695 00
Glassware	73 85
Hardware, iron and steel	1,942 96
Iron kettles	227 90
Ice	312 09
Lumber	239 08
Oils	164 67
Petty accounts (sundries)	404 27
Plumbing	236 25
Rubber fire hose	212 30
Repairs	1,243 34
Stationery, books, and printing	172 38
Sawdust	7 76
Sundries	310 80
Telegrams	176 07
Traveling expenses	58 25
Water	1,035 00
Washing	79 00
Wood	909 12
Total	13,109 81

EARNINGS OF THE CARSON MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Charges collected for parting and refining bullion	$9,864 42
Charges collected for alloying gold coins	88 60
Seigniorage on standard silver dollars coined	47,830 29
Proceeds of sale of old material	915 00
Total	58,698 31

EXPENDITURES OF THE CARSON MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Salaries of officers and clerks	$23,550 00
Wages of workmen	62,294 62
Contingent expenses, not including wastage and loss on sweeps	11,312 73
Parting and refining expenses, not including wastage and loss on sweeps	4,492 08
Expenses of distributing standard silver dollars	108 00
Value of the gold and silver wastage of the operative officers	476 66
Total	102,234 09

PERSONNEL OF THE CARSON MINT, JUNE 30, 1880.

General department, officers, clerks, and assistants	32
Assayer's department, officers, clerks, and assistants	5
Melter and refiner's department, officer, clerk, and assistants (three refiners included)	9
Coiner's department, officer, clerk, and assistant (nine lady adjusters included)	20
Total	66

UNITED STATES MINT AT SAN FRANCISCO, CALIFORNIA.

This mint was visited and reported upon in May, 1881. During the fiscal year ending June 30, 1880, nearly corresponding to the census year, it had coined 10,194,950 pieces, of a value of $36,053,000, running only one shift of eight hours per day. The chief work had been on double-eagles and silver dollars, the value of the former having been $19,216,000, and of the latter $7,910,000. The earnings, including seigniorage on standard dollars, were $1,129,448 74, and the expenses $502,578 67. The total force employed was 257. The San Francisco mint is of large capacity, and is equipped in the very best manner.

MELTER AND REFINER'S DEPARTMENT.

REFINERY.—The refinery includes the corroding-room, the press-room, the reducing-room, and the laboratory, and forms an L on the second floor. The regular force consists of thirteen men, but had been increased to nineteen at the time of the examination, owing to the change in process.

The nitric-acid process.—At the time of examination of this mint the apparatus for the nitric-acid process was being replaced by plant for treatment by the sulphuric-acid process. As the former method is being universally supplanted by the better and more economical process of parting by sulphuric acid, a record of the practice at this mint may be of interest.

Dissolving.—The bullion was dissolved in white stoneware jars imported from Germany, of which forty were in stock, thirty-seven having a capacity of 25 gallons and three holding 18 gallons each. The charge of crude granulated metal averaged 100 pounds per jar, and the quantity of acid added averaged 200 pounds, varying, however, with the quality of the bullion. If the bullion contained much coppery base metal, more acid was required. The strength of the acid was 38° Baumé. The jars were placed on the floors of wooden inclosures, called corroding houses, which were filled with boiling water to a depth of 8 inches. Heat was supplied by live steam from the engine boilers through a coil of iron and copper pipes. There were four of these corroding houses, two having space for twenty-four dissolving jars each, and two holding twelve jars each. The boiling required on an average six hours, though sometimes it was continued for seven hours. At the end of this period the jars were filled with distilled water and allowed to settle over night. The next morning the liquid was siphoned off, and the jars were removed from the bath and emptied of the gold, which was washed and filtered. The gold was then boiled with sulphuric acid of 62° Baumé in iron kettles, washed, pressed in cloth, and dried.

Precipitating.—The acid solution of silver and other nitrates was placed in a precipitating tub and the silver thrown down as chloride by the addition of a strong solution of sodium chloride. The precipitating tubs, of which there were two, were of wood, 10 feet in diameter and 6 feet deep, holding about 5,000 gallons each, and had wooden false bottoms. They were provided with revolving stirrers, and resembled very closely the agitator of a silver mill. After two hours the liquid was drawn off through faucets and filtered. The precipitated chloride of silver was washed in hot undistilled water for eighteen hours or more until freed from all acid, the hot water removing also the small amount of lead present.

Reducing.—The clean chloride was then placed in vats and reduced by granulated zinc. There were six of these reducing vats, each holding 6,000 ounces of chloride. They were rectangular, wooden, and lined with sheet lead. The chloride was first charged into the vats, then the zinc, and water (undistilled) was added. The proportion of zinc to chloride averaged 2,435 ounces of the former to 6,000 ounces of the latter. The charge was stirred with wooden paddles. About six hours were occupied in reduction, or seven hours including the time required for charging, washing, and changing. The zinc salt formed was a waste product, and allowed for in fixing the refining charge. The metallic silver was washed from two and a half to three hours with undistilled hot water in wooden filtering vats lined with lead about 3 feet in diameter. Seven of these vats were in use. The clean silver was formed into cakes by hydraulic pressure and dried. The press was driven by a 10-horse-power engine, and exerted a pressure of 40 tons. It had been in use since 1855. Nine of the pressed cakes gave 3,600 ounces in bars. The drying furnace had a capacity for one hundred and twenty silver cakes. The fuel was redwood, and the heat was maintained at a cherry red. The operation of drying could be finished in six hours, but it was the practice to do the drying over night. The subsequent manipulations were the same as now performed. The dried cakes were melted into mint-fine bars and turned into the melter and refiner's office, the customary sampling and assaying being done by assay bars.

The sulphuric-acid process.—The first kettle charge by this process was made April 19, 1881. The method followed is in general the same as that already detailed in the description of the Carson mint, with, however, the following exceptions: The fire under the parting kettles is started with charcoal and coke and then fed with anthracite. The bullion is charged in the form of granulations, not in shoe-bars. This practice was adopted to avoid dispute with the patentee of a process for parting bars without granulation. The usual charge weighs 4,500 ounces, but if the bullion is of good quality the kettle will safely hold 6,000 ounces. The proportion of acid used is from 3 to 4 pounds per pound of bullion, according to the quality of the latter. If the bullion is very coppery, it requires correspondingly more acid, but in such cases a weaker acid than 62° is used. The first boiling occupies from five to six hours, and the charge is cooled and settled in two hours or is left over night in the kettle, according to the quality of the metal. In discharging the kettles the solution is siphoned off first, the gold being pushed to one side, to allow room for the siphon pipe. This plan has the advantage over that of first ladling out a part of the gold, as it does not subject the operator to the same exposure to the acid fumes.

There are four 20-inch furnaces and four cast-iron kettles for reboiling the parted gold. Each kettle is 33 inches in width at the top and 14¾ inches deep, and holds 15 gallons. Gold parted by nitric acid requires six or seven hours' reboiling, but that parted by sulphuric acid requires only two hours.

The filtering tubs for gold are of wood, each 26 inches in diameter and 23½ inches deep, holding 25 gallons. One small porcelain jar is also used. The straining material is ½ unbleached muslin in three qualities. Drilling and blankets are also used.

Three and sometimes as many as five charges of acid are generally made; washing is occasionally repeated ten or twelve times. The sweetened gold is at this mint dried in a furnace, just as is the silver cake before melting.

There are two large precipitating vats for the silver-sulphate solution. These have inclined top doors. The proper strength of the solution is reported at 18° Baumé. Precipitation is completed in two days of eight hours' heating each. The copper is used in slabs 24 inches long, 10 inches wide, and 1¼ inches thick, disposed upon the bottom and upright along the sides of the vats. The charge of copper is 3,000 pounds. The precipitated silver is filtered, washed, pressed, and dried as usual. The bluestone formed is crystallized and recrystallized, and is sold in the San Francisco market.

The floors of the press-room and the laboratory are covered with sheet lead, and the other rooms of the refinery are floored with asphalt.

MELTING ROOMS.—The gold and silver are melted in separate rooms. The gold-ingot melting room contains six furnaces 14 inches square. The plumbago pots used are Nos. 45 and 50, and occasionally No. 60. In melting gold, charcoal and occasionally hard coal are used. The silver-ingot melting room has also six furnaces 14 inches square, and the same sizes of crucibles are employed in this room. Charcoal, coke, and hard coal are used as fuel. The furnaces for ingot melting are of the Feix pattern, having a series of air chambers and a water-jacket condenser to diminish the loss by volatilization. The fluxes used are borax, niter, sal ammoniac, bone-ash, and powdered charcoal.

The deposit-melting room contains four furnaces, 14 inches square, for melting bullion on its receipt. There are also in this room six furnaces for melting the large bars to be granulated previous to parting. Four of these are 16 inches and two are 22 inches square. The granulating tubs are of copper, having each a capacity of 100 gallons or more. Charcoal, coke, and hard coal are used as fuel.

The zinc used in reducing the chloride of silver comes in slabs 14 by 7 by 1 inches. A special furnace, 14 inches square, for granulating this zinc is in the basement. There are also two copper-melting furnaces, 14 inches square, in the basement. The copper is melted in Nos. 45 and 50 plumbago pots, and is refined by the Feix process.

The sweeps room has two ovens for drying sweeps, a Chili mill, two amalgamators and concentrators, and a large vat for collecting the sweeps after washing.

In the refinery 7 trucks and 24 carrying tubs are used for transporting bullion, chloride, etc.

A condenser in the attic supplies 2,000 to 3,000 gallons of distilled water per day for use in the assay department and refinery.

COINER'S DEPARTMENT.

The manipulations involved in making coins from the standard ingots are similar to those practiced at the Carson mint with but slight deviations in method, but they are conducted on a much larger scale. The writer is indebted to Mr. Frank X. Cicott, the coiner, for full notes on the system of checks against loss or error followed in this department.

Receiving ingots.—The transfer clerk delivers the ingots to the coiner's department. They are weighed by him in the presence of the coiner's receiving clerk and the melter and refiner, or his representative. The delivery is made in quantities called "melts". Each melt for double-eagles is composed of forty ingots, weighing about 3,000 ounces. When the transfer clerk weighs the melts he takes the weight, number, and denomination of the ingots, as well as the number of ingots composing each melt, and makes the proper entries in his book. The receiving clerk of the coiner's department and the melter and refiner's clerk do the same. Then they carefully compare their respective accounts, and if these agree the melts are turned into the coiner's office, whence they are passed into the rolling-room.

Rolling-room.—This is between the coiner's office and the cutting-room. The total force is 8 men. Here the number and the weight are again taken and entered in the roller's book. Each melt is provided with a copper tag bearing its number, and this tag remains with it during the whole manipulation.

The rolling-room contains four sets of rollers, two break-down and two finishing, having a pressure varying from 20 to 80 tons. The rolling machines are similar to those of the Carson mint, but have not the flat guides for preventing flexure of the strips. The rolls are of cast iron (not steel, as at the Carson mint). The lubricant is castor-oil.

The ingots are now drawn into strips of about 3 feet 6 inches in length by means of this flattening or drawing process, and naturally become brittle and in some cases are split or broken on the ends. To remedy the brittleness the strips are now prepared for the annealer. First, however, the fractured ends are removed by a powerful cutting machine. The thickness of the rolled strips is tested by gauge instead of by weighing a trial planchette.

Annealing room.—This is on the first floor, between the cutting- and the whitening-rooms. The total force is four men. The gold strips are placed in copper canisters, the silver being annealed in open pans. The canisters are of two sizes, those for "short gold" being 3 feet 10 inches long, $4\frac{5}{8}$ inches diameter, outside measurement, and $\frac{1}{16}$ of an inch thick, and those for "long gold" 5 feet 7 inches long, $4\frac{1}{2}$ inches diameter, and $\frac{1}{16}$ of an inch thick. Each is capable of containing twenty strips. The canisters, after being capped and sealed with fire-clay, are placed in a reverberatory furnace, four at a time, where they remain for about one hour. There are four annealing furnaces. The fuel is oak. An hour is usually required with a moderate fire; much, however, depends upon the operator, he being guided solely by his judgment, as no established rule exists. The main point is to see that the heat is equally distributed, and to insure this the canisters are turned half over at intervals of fifteen minutes. Great care must be taken to avoid overheating. When sufficiently heated the canisters are removed from the furnace, by means of iron tongs, into vats containing cold water, and in three or four minutes the caps or seals are removed so as to allow the water to enter. When sufficiently cooled, the strips are dried with cotton cloths and then removed to the rolling-room, to be passed through the finishing rolls and reduced to the required thickness; *i. e.*, the thickness of the coin for which they are intended, which could not be done prior to the annealing by reason of their brittleness. This operation completed, the strips are again returned to the annealing-room for final annealing, which is a necessary preparation for the cutting machine.

Cutting-room.—The cutting-room is on the first floor at the west side of the building, between the rolling- and the annealing-rooms. The force employed in this room is nine men, and two others are engaged in the cleaning room. From the annealing-room the strips are taken to the pointing machine, which shapes the end of each strip so as to admit it with facility in the orifice of the draw-bench, where the strips are reduced to the exact thickness necessary. Before being subjected to the operation of the draw-bench, however, the gold strips are heated to a temperature of 100° F. in a steam chest, and then they are separately covered with melted wax. They are now taken to the draw-bench; one strip is drawn through and passed to the cutter, who cuts off one planchette from the first end and one from the middle of the strip. These planchettes are passed to the foreman of the cutting-room, who weighs them. If he finds them correct, the strip is cut into planchettes. This same operation is performed with each strip. If one is found too heavy, it is again placed in the draw-bench and reduced; if too light, it is placed upon the "light bench", when it is cut by a concave punch, thus correcting the deficiency. There are three draw-benches and four cutting-presses in this room. When all the strips are cut the planchettes and clippings are sent to the cleaning-room.

Cleaning-room.—Here they are boiled in a solution of potash, for the purpose of removing the wax and rendering them perfectly clean. After this they are rinsed in boiling water and dried in a pan heated by steam. When perfectly clean and dry the planchettes are adjusted. The clippings and chips are returned to the transfer clerk in the same manner that the ingots were received.

Adjusting-room.—Gold planchettes are treated as follows: Each planchette is weighed separately, and if too heavy it is reduced by filing the rim by hand; if too light, it is passed to the "light weigher", who weighs it, and in

case it is found to be below the legal limit condemns it. The "standard weighers" weigh every standard gold planchette several times to insure correctness. The adjusting force includes fifty-nine women adjusters and weighers and one forewoman. After all the planchettes have been adjusted, the assistant adjuster takes the different pans of standard planchettes and makes them up in what are called "drafts" of 1,000 pieces each. These drafts are again weighed in the coiner's weigh-room. In the case of double-eagles the draft weighs 1,075.10 ounces, being 0.10 ounce in excess of the legal weight, the surplus being added for loss in whitening and pressing. The legal tolerance allowed on a double-eagle, light or heavy, is 0.5 grain. The working limit used is 0.1 grain on the "standards" and 0.3 grain on the "lights". The "standards" and "lights" are kept in separate boxes containing cards setting forth the exact weight and date of adjustment. The "condemns" are also kept separate, and are so marked.

Silver planchettes are not adjusted by hand, but those for the large coins are, if necessary, filed by lathes in the coiner's weigh-room. There are two of these filing machines in this mint, and one has been furnished to the New Orleans mint. They reduce twenty pieces at a time very conveniently and rapidly. The strips for dimes and quarters can be adjusted without difficulty at the draw-bench, but those for half-dollars require much care to keep them within the prescribed limits.

Whitening-room.—The gold blanks are placed in iron flasks, which are sealed with fire-clay and placed in the heating furnaces. Silver blanks are charged into the furnaces in copper pans. When thoroughly and uniformly heated the blanks are thrown into a hot bath of water acidulated with sulphuric acid, the same kind of pickle being used for both gold and silver. After remaining in the bath four or five minutes, during which time they are stirred with copper rakes, the blanks are removed, rinsed with boiling water, and dried in steam-heated open pans with basswood sawdust, being stirred with wooden paddles until dry. The wastage of gold blanks is reported to be the same as at Carson; that of silver blanks is stated at from 0.20 to 0.30 grains per draft treated. The force employed in the whitening-room is a foreman and four assistants.

Press-room.—After the whitening process, and having been reweighed, the blanks are delivered to the foreman of the press-room and coined. The press-room is at the southwest corner of the first floor. It contains six coining presses, four of which are used in making double-eagles and standard dollars. These larger presses turn out eighty pieces per minute, and exert a pressure which is stated at 175 tons or more. One of these, known as Black Bess, was taken to San Francisco before the construction of the first mint there, and was used by private coiners. It has been in operation very steadily, and is said to have coined over $400,000,000 gold. Another press is of the Ajax model, previously described. The smaller presses coin subsidiary silver or small gold pieces. They strike from one hundred and twenty to one hundred and forty pieces per minute, exerting a pressure of from 30 to 60 tons, according to the denomination made, and have brass levers. The lubricant for the presses is refined sperm oil.

From the press-room the coin is returned to the weighing-room. After coining the dies are taken from the presses and stored in a vault.

The "making-up" of coins.—The legal weight of $20,000 in double-eagles is 1,075 ounces. The number of pieces requisite to represent that sum are placed in a steel pan upon the scales. In case the weight is too great, some of the pieces are withdrawn and are replaced by "lights" until the legal weight is obtained. The coin is then put into boxes, 1,000 pieces in each, and the superintendent is notified that an amount of coin is ready for delivery. The cashier of the mint, representing the superintendent, selects the number of coins provided by law from each box and weighs them with his standard weight. If the weight is within the legal limit, the delivery is accepted, and a receipt is given. The assayer's representative also takes one piece (which he replaces by another), to be disposed of as the law directs. The condemned blanks and coins are delivered to the superintendent in the same manner as the clippings. The dust and filings are retained until the annual settlement.

System of accounts.—As an instance of the care taken in the mints to prevent loss or error and to keep a complete and intelligible record of all operations an outline of the system of bookkeeping practiced in the coiner's department of the mint is quoted below from a report made by Mr. Cicott. In the other departments of the mint, and indeed throughout all the branches of the mint bureau, a similar system is observed. It would be well if the same care were taken in all mining and metallurgical establishments, for comparisons and improvements in practice can best be made by means of accurate records of daily results. A few of the mining companies pursue the plan of recording their operations in some detail, and it is noteworthy that in precisely such cases the closest and most successful working is to be found. This is to be expected, if for no other reason than that a detailed system of accounts involves constant and minute inspection.

The books containing the accounts with the different branches of the coiner's department in the San Francisco mint are the journal, ledger, working book, cash book, abstract of coinage, and delivery book.

The journal shows a complete record of all receipts of ingots and delivery of coin, clippings, and "condemns" by days, and fully specified. The ledger contains the same in daily totals.

The working book contains in different columns: (1) The number of the melt; (2) the weight of the melt and the number of ingots composing it; (3) the roller's account, setting forth the weight of strips, chips, and dust returned, and also stating the amount of loss; (4) the cutter's account, setting forth the weight of planchettes, clippings, and dust returned, and also stating the amount of loss; (5) the adjusting account, setting forth the weight of adjusted blanks condemned, blanks and filings returned, and also stating the loss; (6) the milling and cleaning account,

showing the weight of blanks (annealed) returned, and stating the loss; (7) the press-room account, setting forth the weight of coin turned out, and also stating the weight of blanks injured by accident and condemned; (8) the recapitulation column, showing the amount of coin, "condemns," condemned coin, clippings, chips, dust and filings, and the amount of loss on the total workings.

The cash book contains the amount of coin daily made, in ounces, on the debit side. On the credit side it shows the amount delivered, in ounces and dollars; also the number of the delivery.

The abstract of coinage shows the weight of ingots received monthly, and the amount in dollars of the several denominations (in separate columns) of coin delivered.

The delivery book shows the number of the delivery, the number of drafts, the amount in dollars, the actual weight, the legal weight, the variation, and the denomination of all coin deliveries made to the superintendent.

Statements of the entire workings of the coiner's department are rendered to the superintendent weekly, monthly, quarterly, and annually. The pay-roll is made out monthly. The roll-book also sets forth the name, date of appointment, and all particulars regarding the resignation or removal of each employé.

The supplies are procured upon a printed requisition to the superintendent, and copies of all such requisitions are kept in the coiner's office. When bills are presented, they are certified to by the officer in charge and are sent to the superintendent for approval.

ASSAYER'S DEPARTMENT.

The assay department occupies seven rooms at the south end of the second floor, consisting of the office, gold-weighing room, laboratory, fire-assay room, humid assay room, humid assay weighing room, and the furnace and dissolving room. The assay force is twenty-one, including the assayer, assistant assayer, second assistant, foreman, seven weighers, two cupellers, three dissolvers, two chippers, engineer, fireman, and porter. Ten Oertling and two Becker balances are in use.

Sampling.—The chips from deposit assay gold bars are taken in the assay department. They weigh 0.27 ounce each. The silver granulations weigh several ounces, of which 0.45 ounce is taken for each of the pair of top and bottom samples. With large melts of gold the samples are diagonal corner chips from alternate bars cast. The chips of mint-fine gold weigh 0.30 ounce each, and those of mint-fine silver 0.25 ounce.

Assaying.—Duplicate assays are made for gold and for base metal. All assays of silver in silver bullion are made by the humid method of Gay-Lussac. The gold in silver bullion is determined by the synthetic method, sufficient gold being added to keep the cornet from breaking. All silver assays are reported in tenths of thousands fine.

Apparatus.—There are two muffle furnaces in the furnace room. They have three muffle doors, of which the upper is used for annealing cupels and the two lower for cupelling. There is one assay furnace in the same room. It is 13 inches square, and holds six No. 12 crucibles. The laboratory contains two sand-baths. The boiling is done over a series of large gas-burners. Four pairs of power-rolls are in use—one for lead, one for gold, one for silver, and one for rolling cornets. There are two shaking machines for the humid assay, similar to that at the Carson mint. They are driven by rod from a small upright engine.

MISCELLANEOUS.

The building.—The mint is on the west side of Fourth street, occupying a lot which has a block front between Mission and Jessie streets. It is of Portland freestone, with granite and concrete foundations. It has two stories, a basement, and an attic. The girders are of iron, and the roof is of galvanized and corrugated iron, except in a small part, which is of wood sheathed with copper. The extreme dimensions are 296 by 163 feet. There are two stacks, about 130 feet high, one used for the boilers and whitening rooms and the other for the refinery, though the two can be used in connection. The building was designed by A. B. Mullett, architect, and upon its completion, in 1874, the old mint building was abandoned.

Boilers.—There are four boilers, arranged in pairs, but so connected that one or more may be used independently. They are 48 inches in diameter, 15 feet long, and have thirty-eight 3½-inch flues each. They consume about 3 tons of coal per day, when all are in use. The boilers are on the ground floor.

Engines.—There are five engines in this mint. The largest, known as No. 1, drives the rolls only. It is a parallel motion beam engine, with vertical cylinder 20 by 45 inches, has Myers' cut-off, and is rated at between 150 and 200 horse-power. The speed is forty-five strokes per minute, and is regulated by a Gardiner governor placed 5 feet from the steam-chest. It was made in San Francisco, and is a fine example of workmanship.

No. 2 drives the coining presses and draw-benches, and is in constant use. It is a direct acting 12- by 24-inch 50 horse-power engine.

No. 3 runs the elevator and the machinery of the sweeps room (Chili mill, amalgamators, etc.). It has a vertical 8- by 12-inch cylinder, mounted over the crank-pin, and is rated at 15 horse-power.

No. 4 furnishes power for the hydraulic press. It has a 7- by 10-inch cylinder, and develops 10 horse-power.

No. 5 is a small vertical 8 horse-power engine in the assay department. Its cylinder, 6 by 8 inches, is over the crank-pin.

The following statement shows the working results of an average month:

SYNOPSIS OF ENGINEER'S LOG, SAN FRANCISCO MINT, FOR THE MONTH ENDING JANUARY 31, 1881.

Coal consumed, tons of 2,240 pounds		75
Percentage of waste in ashes and clinker		19.5
Feet of wood consumed		11
Number of hours fires were lighted		237
Average pressure of steam on boilers	pounds	65
Average temperature of engine-rooms	degrees Fahrenheit	87.5
Average temperature of fire-rooms	do	75.5
Average temperature of feed-water	do	140
Number of hours run, engine No. 1		109
Number of hours run, engine No. 2		203
Number of hours run, engine No. 3		65
Number of hours run, engine No. 4		86
Number of hours run, engine No. 5		192
Number of hours steam used in refinery		85
Number of hours steam used in waxing machines		109
Number of hours steam used in drying-rooms		141
Number of hours distilling water		87
Number of hours steam-pump running		175
Average revolutions per minute of engine No. 1		41.5
Average revolutions per minute of engine No. 2		80
Average revolutions per minute of engine No. 3		169
Average revolutions per minute of engine No. 4		175
Average revolutions per minute of engine No. 5		180
Gallons of oil consumed		10
Pounds of cotton waste consumed		45
Pounds of lubricating cream consumed		10

Pumps.—Two steam pumps are used in connection with the artesian wells. There are two of these wells on the ground, one 200 feet and one 250 feet deep. The pumps raise from 40,000 to 60,000 gallons, the amount required by the mint, in eight hours. They take steam at 65 pounds pressure. The water is decanted before being fed to the boilers, but no chemicals are used.

DEPOSITS AND PURCHASES OF GOLD AND SILVER BULLION AT THE SAN FRANCISCO MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Description.	Gold.	Silver.	Total.
Re-deposits, unparted bars	$116,111 22		$116,111 22
Bullion of domestic production	27,546,640 57	$9,967,566 59	37,514,207 16
United States coin	55 00	6 00	61 00
Foreign bullion	264,785 86	861,488 68	1,126,274 54
Foreign coin	599,739 45	12,222 21	612,961 66
Jewelers' bars, old plate, etc	18,212 36	107 10	18,319 46
Gold and silver received and operated upon	28,545,544 46	10,842,390 58	39,387,935 04
Less re-deposits	116,111 22		116,111 22
Total deposits and purchases	28,429,433 24	10,842,390 58	39,271,823 82

DEPOSITS AND PURCHASES OF GOLD AND SILVER OF DOMESTIC PRODUCTION AT THE SAN FRANCISCO MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Source.	Gold.	Silver.	Total.
Alaska	$5,950 90		$5,950 90
Arizona	152,967 26	$831,616 67	982,983 93
California	7,033,656 05	283,734 46	7,317,390 51
Colorado	338 72		338 72
Dakota	64,350 06		64,350 06
Idaho	365,570 55	88,724 16	454,294 71
Montana	16,441 84	256,686 30	273,128 14
Nevada	38,119 81	4,122,732 53	4,161,852 34
Oregon	552,280 41	1,174 26	553,454 67
Utah	13,295 30	11,827 38	25,122 68
Washington	34,529 24		34,529 24
Wyoming	328 84		328 84
Refined bullion	18,161,943 52	2,970,757 92	21,132,701 44
Parted from silver	1,106,968 07		1,106,968 07
Parted from gold		78,278 43	78,278 43
Other sources		1,319,234 48	1,319,234 48
Total	27,546,640 57	9,967,566 59	37,514,207 16

COINAGE EXECUTED AT THE SAN FRANCISCO MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Denomination.	Pieces.	Value.
GOLD.		
Double-eagles	900,800	$19,216,000
Eagles	461,250	4,612,500
Half-eagles	862,900	4,314,500
Total gold	2,284,950	28,143,000
SILVER.		
Dollars	7,910,000	7,910,000
Total coinage	10,194,950	36,053,000

EARNINGS OF THE SAN FRANCISCO MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Charges collected for parting and refining bullion	$158,477 34
Charges collected for alloying gold coins	2,743 24
Seigniorage on standard silver dollars coined	965,279 71
Amount received for assays of ores	99 00
Grains, fluxes, and sweepings from deposit-melting room	1,393 70
Proceeds of sale of old material	1,455 75
Total	1,129,448 74

EXPENDITURES OF THE SAN FRANCISCO MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Salaries of officers and clerks	$24,900 00
Wages of workmen	252,235 75
Contingent expenses, not including wastage and loss on sweeps	41,313 81
Parting and refining expenses, not including wastage and loss on sweeps	137,671 98
Expenses of distributing standard silver dollars	210 18
Value of the gold and silver wastage of the operative officers	29,273 07
Loss on sale of sweeps	16,973 88
Total	502,578 67

WASTAGE AND LOSS ON SALE OF SWEEPS AT THE SAN FRANCISCO MINT DURING THE FISCAL YEAR ENDING JUNE 30, 1880.

Melter and refiner's gold wastage	$5,258 82
Coiner's gold wastage	2,188 32
Melter and refiner's silver wastage (a)	21,706 69
Coiner's silver wastage	119 24
Loss on sale of sweeps	16,973 88
Total	46,246 95

PERSONNEL OF THE SAN FRANCISCO MINT, JUNE 30, 1880.

Superintendent	1
Melter and refiner	1
Assayer	1
Coiner	1
Chief clerk	1
Cashier	1
General department	63
Assay department	21
Melting and refining department	53
Coiner's and adjuster's departments	114
Total	257

a Largely owing to the fact that no deduction from the weight of low grade and refractory bullion, as authorized, had been made.

APPENDIX I.

THE MINING INDUSTRIES OF UTAH.

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[NOTE.—While it would be extremely desirable to present, from the material collected by the special agents of this branch of the census, a complete and detailed account of the mining and metallurgical operations in all the states and territories, in order that the relations of the various factors involved in the industry might be clearly exhibited, still the limited space allotted to this volume of the census reports renders such a full presentation impracticable, and necessitates the substitution of a report more general in its character. It is felt, however, that, though from the above reasons it would be impracticable to give a detailed review of the industry in every section, the selection of some one for more minute discussion would, to some extent, supply the place of the fuller description.

It has been extremely difficult to determine which one of the states and territories would the best serve as a type or illustration. Each has its peculiar features, which distinguish it from the others, and each has many general features in which it resembles the others. It was necessary in the selection, on the one hand, not to choose one which so far excelled the others in its mining and metallurgical advancement as to give a false and too highly-colored idea of the progress of the industry over the whole country, and, on the other, not to take as a type one whose industry was in the early stages of its development, and thus give a depreciative impression equally erroneous.

The precious-metal mining industry of Utah appears to present features of peculiar interest from a technical point of view. Mining in this territory seems to have reached a stage which may be taken as fairly representative of the progress which has been made elsewhere in the country. The mineral resources are more varied in their character than is the case in any other region, with the possible exception of California and Colorado. The territory occupies an intermediate geographical position, its product is midway in importance, and the costs of labor, supplies, etc., are neither low, as in older mining communities, nor exceedingly high, as in newer and less developed localities. Its mining mechanical appliances, it is true, have not been brought to the degree of perfection which has been reached in Nevada, nor are they of the crude order prevalent in new places; still, the metallurgical plant and processes of its principal works illustrate by their many past experiments and failures the various stages of development in metallurgy in this country. In short, though gold mining is not an interest of fully proportionate importance, the territory is fairly typical in a sense which does not exist in the case of any of the other mining states and territories.

In view of these considerations, and of the fact that much information of importance regarding Utah has hitherto escaped publication, the territory has been selected for a somewhat detailed description.

Mr. D. B. Huntley, the special expert detailed to Utah, has prepared such a technically complete summary of the results of his investigations that it has had no little weight in the selection of the section covered by his report for more minute discussion. His report is here presented in a somewhat abridged form.]

The territory of Utah is a rich mineral country, but in general, owing to causes which will hereafter be discussed, its mining prosperity at the period under review was not commensurate with its mineral wealth. Although the Ontario continued to declare its monthly dividends, and work was being steadily prosecuted at the new districts of Frisco and Silver Reef, yet the former great ore-producing districts of West Mountain and Big and Little Cottonwoods were comparatively idle. In some instances mines which formerly employed a hundred men were not even being prospected, but were abandoned to three or four men, who were engaged in picking over the dumps and searching the workings for ore which had escaped extraction. Practical and energetic labor is confined to a few large mines, the output of which presents a strikingly noticeable falling off in the total bullion product, so that one attempting to judge of the condition of the industry, using this as a criterion, is apt to be misled. Extraordinary exertion in the development of a few rich properties do far less toward the real and substantial advancement of mining as a general profitable industry than does the continued systematic and practical working of many mines, even though smaller. Though there was a lack of energy and activity in very many quarters, still a large amount of prospecting was being carried on, particularly in the region of Parley's park and the Cottonwoods, and, on the whole, it is probable that the next computation will show an increase in the total bullion product, even though an increase far short of possibilities. In the low prices of food and moderate rates of transportation the territory possesses marked advantages.

The reports and the recollections of sundry outrageous swindles perpetrated in the past on too confiding investors have operated not a little in frightening away capitalists, more especially foreign ones, who have in a majority of the instances been the victims, having been selected as more likely to prove easy prey on account of their unfamiliarity with mining matters. This has been no small drawback to advancement.

In the early days of the industry in this territory reduction presented few difficulties, as the large surface bodies were of oxidized ore and easily worked. As these were exhausted and lower levels were reached mining became more difficult and the ores more rebellious. The old simple methods and machinery were found to be of

little use. New methods and new machinery had to be invented and purchased. These expenses in many cases soon consumed the early profits, and left the mine owners without means to prospect extensively, or even to erect pumping machinery to follow known bodies. Then, again, the rich discoveries in Colorado, Arizona, and Idaho, during the three years preceding the period under review, turned the attention of investors in those directions, and, in consequence, capital was diverted from the old mining districts. In this way the industry in Utah suffered greatly. In all probability, however, the prime factors in the existing dullness have been the exhaustion of the surface bodies and the reaching of the water level, with the consequent change in the character of the deposits. Ore which, at the surface, consisted of carbonates and sulphates of lead in a soft ocher, changed, below, to pyrite, galena, and sometimes to zincblende, in a hard siliceous or calcareous rock. The increase in the quantity of pyrite lessened the value of the ore and made smelting more expensive. Again, this hard ore cannot be so cheaply extracted or concentrated. In working the surface bodies the miner had learned to follow the ocher stain with faith that it would lead to ore. Below the water line this guide was wanting, and the ocher stain was usually replaced by a much narrower band of rock containing pyrites. The latter is not more difficult to follow than the former to one trained to it, but, by reason of a lack of experience, so few have been followed in depth with success that when the pyrite was reached mines were deemed almost valueless. The surface bodies did not alone contain all the ore worth working, but at the then existing prices, and with the methods of treatment employed, they contained all that could be worked with any profit. The great need of Utah at present is concentration works. As far as depth is concerned, mining in this territory is in its infancy. A careful study and the application of the processes of concentration to the great quantities of low-grade ore will be requisite to the profitable prosecution of mining in many of the districts. Concentrating on a small scale is now practiced, though, for the most part, in but a rude way, and it is principally confined to the separation of nodules and crystals of anglesite, cerussite, and galena from a fine ocher. Machinery is needed for the separation of galena, pyrite, and sphalerite from one another.

In several of the older districts the days are nearly at an end when mines can be worked profitably by single individuals or partnerships having but a small capital, unless rich surface bodies are chanced upon. Their mines will have to be worked by wealthy companies with the means to construct extensive apparatus for the concentration of the low-grade material found between the bodies of rich ore.

Wonderful progress has been made in metallurgy in the United States during the last thirty years. The mineral resources of the country form so large a part of its natural wealth that the inventive genius of the people has been stimulated to the extreme in the production of methods and machinery for their development. But when the necessity has arisen for a new method, or a new machine, the inventors have relied too much on themselves and their own ability, and have studied too little what has been done in the same direction in other countries. Thus, in some instances, time and money have been wasted in reinventing and testing machines which in other places and in other times have proved failures. The first requisite of an inventor is a knowledge of what has been done by others in the line to which his efforts are to be devoted. In Germany, Austria, and France great attention has been given to concentrating apparatus. The ores which it has been necessary to handle in those countries are very like the pyritous ores of Utah and some of the heretofore neglected and despised low-grade veins. A thorough study of the continental methods would be of great advantage.

It may not perhaps be out of place to give here a chronological summary of the history of the territory as far as it is connected with mining:

July 24, 1847.—Arrival of Brigham Young and a few Mormons on the site of Salt Lake City.

1858.—Arrival of General Johnston's army.

1861 to 1863.—A few tons of lead claimed to have been obtained by the Mormons from the Rawlings mine, in Beaver county.

October, 1862.—Arrival of California volunteers under General P. E. Connor for the protection of the settlers. General Connor early saw that the Mormon question could best be solved by the encouragement of outside immigration. The opening of mines, he thought, would do this, and so he gave furloughs to squads of his soldiers, old California miners, to prospect the country.

September 17, 1863.—Jordan mine located by the soldiers in the West Mountain district. First location in Utah.

Summer of 1864.—Discovery of the Emma and other mines in the Little Cottonwood district. First smelter (a reverberatory one) erected at Stockton by General Connor and officers. It proved a failure.

1869.—Completion of the Central Pacific and Union Pacific railroads.

June, 1870.—First efficient smelter (a cupola one) erected by Woodhull Brothers, 7 miles south of Salt Lake City.

1870.—Utah Central railroad completed.

1870 to 1872.—Mining excitement in Utah. Many stacks erected, but not all successful.

Spring of 1871.—Sale of the Emma mine.

1871.—Utah Southern railroad commenced.

July, 1872.—Discovery of the Ontario mine, in Summit county.

May, 1873.—Wasatch and Jordan Valley railroad (Little Cottonwood) completed.

December, 1873.—Bingham Cañon and Camp Floyd railroad completed.

1874.—First concentration works in Utah erected at Bingham Cañon.

1875.—Dicovery of the Horn Silver mine, in Beaver county.

Fall of 1876.—Ontario mill erected.

1876.—Mining excitement at Silver Reef.

1877-'78.—Leaching works erected at Bingham Cañon.

1878.—Utah and Pleasant Valley railroad completed.

During the census year Utah produced gold and silver as follows:

	GOLD.		SILVER.		Total value.
	Ounces.	Value.	Ounces.	Value.	
DEEP MINES.					
From ore raised and treated during census year	13,063.4	$270,045	3,555,538.0	$4,596,554	$4,866,599
From ore raised prior to, but treated during census year	74.6	1,542	112,895.0	145,962	147,504
Total from deep mines	13,138.0	271,587	3,668,433.0	4,742,916	5,014,503
From placer mines	967.5	*20,000	*132.5	*171	20,171
From all mines	14,105.5	291,587	3,668,565.5	4,743,087	5,034,674

*Estimated.

The base bullion production of the Utah smelting works for the census year was as follows:

	Pounds.
Refined lead	2,586,370
Crude bullion, including weight of silver and gold contents	28,213,501

The weight and value of the precious metals contained in base bullion were as follows:

	Ounces.	
Gold	4,511.4	$93,259
Silver	1,813,906.0	2,345,199
Total		2,438,458

Deducting from the crude bullion product 322,170 pounds produced from Idaho, Montana, and Nevada ores smelted in Utah, the remainder, 27,891,331 pounds, is the yield of Utah ores smelted in the territory. To this should be added 865,500 pounds of crude lead bullion, the estimated yield of Utah ores smelted in Chicago and in Omaha. The total crude bullion product of Utah for the census year is, therefore, 28,756,831 pounds.

The purpose of the following pages is to represent substantially the condition of the mining industries of the territory during the census year. They will embrace detailed information concerning individual properties only in cases which appear representative or illustrative. Such information of an historical character as has been obtained will be noted when it is of sufficient interest or importance. In the collection of the material for this report the writer has been obliged, in many instances, to rely wholly on the statements of individuals whose interests and prejudices may have influenced their statements consciously or unconsciously. Such data have been carefully weighed, and a liberal allowance has been made for exaggerations. Wherever values of former products have been given, it must be borne in mind that they refer to the price received for the ore or bullion sold in currency, and not in gold, unless specifically so stated. It is due to the mining men of Utah to state that they were not only courteous to the expert charged with the duty of collecting the statistics, but nearly always ready to furnish the desired information at the cost of considerable time and trouble to themselves.

SALT LAKE COUNTY.

The principal mining districts of the county are the West Mountain, Big Cottonwood, and Little Cottonwood. In the neighborhood of South Cottonwood and Sandy there is a group of smelters and sampling mills. In discussing the condition of the mining industry each district will be taken up separately, and the various groups and localities treated of by themselves.

WEST MOUNTAIN MINING DISTRICT.

[December, 1880.]

The West Mountain mining district is situated on the eastern slope of the Oquirrh range. Its breadth from east to west is about 20 miles, and its length is 35 miles from north to south. The mines, however, are included in an area some 5 miles square. It was the first mining district organized in the territory, and its first mine, the Jordan, was located September 17, 1863. The records show that about 6,500 locations have been made, but at the time of the visit probably not over 600 or 700 claims were held, and but 63 of these were patented.

There are no published maps of this district, so that a brief outline of the topography of the section in which claims have been located may, perhaps, be of some assistance in making more clear the position of the groups and individual mines and works described. The trend of the Oquirrh range is north and south. The plain of the Jordan valley rises gradually to the base of the range, at which point its altitude is about 5,400 feet. The crest of the range, about 8 miles from the foot-hills, is between 9,000 and 10,000 feet high. The mines are located within 3 miles of the summit, and are scattered through four cañons opening into the Jordan valley. In order, beginning at the north, they are: Barney's cañon, Bingham cañon, Copper gulch, and Butterfield cañon.

Bingham cañon, the principal one, and containing most of the mines, runs east and west for a few miles, then turns south and follows the trend of the range, with forks and side cañons extending nearly to its summit. On the north the cañon has the following branches: Freeman's gulch, Markham's gulch, and Carr fork, and on the south Bear and Porcupine gulches. Carr fork has as branches Cottonwood fork and Sap gulch on the north, and Ross, Muddy, and Log forks on the south. Joining Butterfield cañon on the north are Yosemite and Blackjack gulches.

The country rock of this district consists mostly of beds of Carboniferous limestone and quartzite. (a) Near the head of the cañon there are great faults, and dikes and masses of augitic granite-porphyry protrude. There are bedded and contact veins in and between the quartzite and limestone, with fissure veins in the syenitic porphyry.

The great lead-producing mines of the district are found in a large bedded vein or belt about 2 miles in length, and dipping N. W. 35° to 60°. Beginning at the southwestern end they are situated in order as follows: Neptune and Kempton, Jordan, Utah, Spanish, Old Telegraph, Revere, first extension west of Telegraph, and perhaps The Lead mine, Miner's Dream, and Wasatch. At the southwestern extremity of this belt, on its hanging-wall side, and branching from it in two forks, is the gold belt of the Stewarts and Jordan. On the same side, and only a few thousand feet from the lead belt at the southwestern end, there are said to be two gold belts which extend into Barney's cañon. These are not well defined, as but comparatively little work has been done. The other mines of the district, with the exception of the Yosemite, Last Chance, and Winnamuck, are as yet relatively unimportant. They are fissure veins in the syenite, or bedded veins in quartzite, having no connection, but having a general northeast and southwest strike.

The district is connected with the outside world by the Bingham Cañon and Camp Floyd Narrow Gauge railroad, which begins at Wasatch Junction on the Utah Southern line, and in 16 miles rises 1,603 feet. Beyond the station in the cañon the road is continued as a tramway for 3 miles and has branches to the principal mines. The freight charge over both tramway and railroad is from $1 25 to $3 per ton, depending on the quantity shipped. In the district there are about 20 hand- and water-power Cornish jigs, which are worked irregularly during the summer months by the owners of the smaller mines.

The following is a brief chronological table showing the development of the district:

1863.—Discovered and organized.
1864.—Gold placers discovered.
1868 to 1873.—Gold placers extensively worked.
1871.—Utah smelter built. Ran from 1871 to 1873.
1871, *autumn*.—Winnamuck smelter built.
1873, *December*.—Completion of Bingham Cañon railroad.
1873–'74.—Jigs at Spanish mine built.
1874.—Concentration works erected by John Longmaid on the Utah mine. Demolished in 1876.
1875.—Old Revere concentration works built.
1875 to 1878.—Discovery of gold belt.
1876–'77.—Leaching commenced; continued two and one-half years.
1877–'78.—Old Telegraph leaching and concentration works on the Jordan river built.
1878.—Stewart mill built.
1878–'79.—New Revere concentrating works built.
1879.—Sale of Old Telegraph property to French company.
1879.—Experimental Jordan 10-stamp mill built.

MINES OF UPPER MAIN BINGHAM CAÑON.

Of the mines of this cañon the Jordan is deserving of special notice. It is the oldest mine in the territory, and was discovered September 17, 1863, by a party of General Connor's volunteers. It is situated 2½ miles southwest of Bingham, on the eastern slope of a ridge of medium size and steepness. The mine was purchased by J. W. Kerr & Co., who, in 1872, erected the Galena smelter (one stack). Afterward the property was bought by Carson & Buzzo, who constructed a wooden flume (5 by 9 feet) 12 miles long, at a cost of $120,000, to furnish water-power. They failed in 1875, and the Galena Silver Mining Company became the owner. In the same year the Galena smelters (five stacks) were built on the Jordan river. In 1877 the property was sold to the Jordan Mining and Smelting Company, which Company was reorganized in 1879, with but slight change of ownership, under the name of the Jordan Mining and Milling Company.

The total product could not be ascertained, but the following approximate figures were given:

	Tons.
Prior to 1873, 18 ounces silver and 42 per cent. lead	7,000
1873 to April, 1875 (higher grade)	17,000
April, 1875, to 1877 (estimated)	50,000
1877 to June, 1880	13,000
Total	87,000

a Geol. Expl. 40th Par., Vol. II, p. 443. S. F. Emmons.

In addition to the above, several hundred tons of gold ore were run through the 10-stamp mill in the census year in experimenting. Its average assay value was $19 90 gold and $8 40 silver per ton.

The property of this company consists of the following claims: Jordan mine, 5,200 by 200 feet patented; the Galena mine, 2,000 by 140 feet patented; the American Flag, Little Mattie, Excelsior, Excelsior No. 2, Steamboat, and some others. These overlap somewhat. The company also owns a 10-stamp gold mill, built in 1879–'80, for the purpose of experimenting on the gold ores; 106 acres of land, one-half of a canal 12 miles long; and a 60-stamp gold mill on the Jordan river, which was begun in 1880, but was not completed when visited.

The Jordan vein is a bedded vein, perhaps 200 feet wide, dipping 30° to 35° NW. in siliceous limestone. The foot-wall may be quartzite. Fragments of limestone from the hillside and hanging wall above have fallen into the vein, forming one or more large horses. On the foot-wall of this vein immense bodies of cerussite with some anglesite and galena were found. They formed almost a continuous body 300 feet in length, and were from 50 to 130 feet (average 70 feet) deep, and from 10 to 100 feet (average 30 feet) wide. Next to the hanging wall is a belt of very friable, porous, ocher-stained gold quartz ore, from 20 to 185 feet in width, from 400 to 500 feet in length, and at least 100 or 200 feet deep. The first-class lead ore taken from the mine in late years assayed about 40 to 45 per cent. lead, 15 ounces silver, and $5 gold. There was some second-class lead ore in the mine and some dump ore averaging 15 per cent. lead, 10 ounces silver, and $3 50 gold. The gold ore assayed from $1 50 to $1,500, and it was claimed it would average $10 or more per ton. At a short distance above the water level, which occurs at about 250 feet on the dip, the oxidized ore changed to pyrites containing a small percentage of copper and lead. One great fault having a north and south strike cut the vein, which was not found beyond this line. The mine is developed by 12 tunnels and three incline shafts to a vertical depth in places of 200 feet, and horizontally for 500 feet. The total length of openings is estimated at 15,000 feet.

The Galena and American Flag are small diagonal cross-veins containing lead ore. The Excelsior is on the same vein as the Jordan, and has about 1,000 feet of openings, showing large bodies of gold ore. There is no machinery upon this group of mines, work being prosecuted by tunnels. During the preceding year or two, many hundred feet of drifts and cross-cuts had been run to open the previously-described gold ore body.

The 10-stamp mill at the mine is a steam gold mill with 500-pound stamps, amalgamated copper-plate riffles, two pans, one settler, one Ball amalgamator, and some tie-boxes for concentration of lead ores. During the census year, while experimenting on the gold ore, but 1,500 tons were worked. The ore is not free, and though it worked well in pans, that was found to be too expensive a process for ore of such low grade.

The 60-stamp gold mill on the Jordan river, 2 miles northwest of Sandy, is a fine, substantial structure, which had cost $60,000 and was not completed. It was thought at the time it was planned that the ore was free milling. Work had been suspended awaiting the result of experiments at the other mill. Its fittings consist of one large engine, two boilers, 4½ by 16 feet, two Blake rock-breakers, 9 by 15 inches, one pair of Cornish rolls, 30 inches in diameter with 16-inch face, with chilled steel shells, Tulloch's self-feeders, 60 850-pound stamps, single discharge mortars, and two electric lights. The ore will be dumped into large ore bins from cars loaded at the mine.

The Steamboat is an east-and-west vein, from 1 to 3 feet wide, in a porphyry dike crossing the northwest end of the Jordan patent. It was originally worked as a lead mine, but in 1877 a pocket of very rich gold ore (oxidized pyrites) was found near the surface 125 feet long and from 75 to 100 feet deep. This yielded, it is estimated, $55,000; and, although some gold had been found in 1876, this was the real commencement of the gold excitement in Bingham. The mine has a 400-foot tunnel and 550 feet of other openings.

The Sheridan Hill Mining and Smelting Company, which failed in 1876, had their stacks on the Jordan river, and worked the Neptune and Kempton, Wall Street (now Northern Chief), and the Damn Fool (now Bonanza). These mines were discovered about 1872, and were vigorously worked in 1874, 1875, and 1876. Their total product for these years is estimated at over $800,000. Since that time but little profitable work has been done.

The Utah mine is an old soldier location. The first smelter in Bingham cañon was erected here in 1871 by Buel & Bateman. In the same year it was sold to an English company at a price said to have been $450,000. This company ran the smelter until 1873, when pyrites were struck. In 1874 concentrating works, costing $40,000, consisting of buddles, tables, jigs, and tie-boxes, were erected by John Longmaid. These did the work comparatively well, but as there was not a ready sale for the mixture of galena and pyrite they were sold to Holden, and the apparatus was moved in 1876 to the Old Telegraph. Since that time the mine has been worked upon lease. About six men were employed during the census year. In 1879, T. R. Jones, a banker of Salt Lake City, bought the property, including several adjacent and overlapping patented locations of 1,500 by 200 feet. The total product has been several hundred thousand dollars, but on the whole it has not paid expenses. The vein is a continuation of the Jordan, and has the same peculiarities of gold ore on the hanging wall and lead ore on the foot wall. One incline was sunk 300 feet, but the general workings of the mine extend 1,000 feet horizontally and 140 feet deep, showing 6,000 to 7,000 feet of openings. The bodies of carbonate ore only extended 50 feet below the surface, where they were replaced by pyrites containing occasional masses of galena. The carbonate ore averaged 45 per cent. lead, 12 to 20 ounces silver, and $4 gold. The gold ore on the hanging wall is 45, 60, 80, and 120 feet wide, where it has been developed by tunnels. The average of 100 assays was $17, of which $6 was free. Chloridizing-roasting would have saved the gold, but it was too expensive.

The Spanish mine is adjacent to the Utah and is on the same belt; but, being on the other side of the cañon, the hanging-wall body of gold ore has been eroded. It was worked vigorously from 1871 to 1878, but since then has been leased. In 1874 four jigs were erected, and in 1876 a water-wheel and steam-engine were placed to run them. It is estimated that the total product of the mine has been 65,000 tons, of which 24,000 tons were extracted in 1876, 1877, and 1878. The approximate assay value was 14 ounces silver, 35 to 40 per cent. lead, and $3 50 to $6 gold. There are about 5,000 feet of cuttings. There is no machinery on the mine. Pyrites and galena are plentiful in the lowest workings.

The names, total length of openings, total product, and condition at the close of the census year of the mines of the Upper Main Bingham cañon, not already referred to, are given in the following table:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Bully Boy	2,000	$40,000	Idle	
Bonnie Blue Flag	2,000	1,200 tons	Being worked on lease	Grade of ore, 15 ounces silver, 40 per cent. lead, and $4 gold.
Ashland	2,400	$20,000	do	
Aladdin	1,100	40,000	do	Grade of ore, 90 ounces silver, 20 to 40 per cent. lead, and $10 gold.
Live Yankee	840	20,000	do	Grade of ore, 100 ounces silver, 30 per cent. lead, and $3 to $10 gold.
Red River group	1,500		Only prospect work done	Average of ninety assays said to be $12 86 gold.
Maple Tree group	2,000		do	Some lead ore has been extracted from the Story.
Alameda and Henrietta	1,300	75,000	Being worked on lease	Product census year, $7,000. Grade of ore, 70 per cent. lead, and 90 ounces silver.
Highland	600	12,000	Worked by owners	
Galena Extension	750	25,000		Grade of ore, 35 ounces silver, 55 per cent. lead, and $4 gold.
Orphan Boy	600		Leased	
Eagle Bird	500		Idle	
Emily	400			
Comfort	400			
Fanny Bemis	850	400 tons	Idle	
Sundown	550	1,000 tons	Active	
Northern Light Company	1,400		Being worked on lease	
Albino	1,000		Idle	
Silver Plume	400		do	
Sanders	550	Few thousand dollars.	Being worked on lease	During census year 35 tons of $50 ore were produced.
Miller	500	Few hundred tons	Idle	

MINES OF LOWER MAIN BINGHAM CAÑON.

The most important mines in this cañon are the Winnamuck and the Tiewaukee, with the adjacent groups belonging to them. The Winnamuck was discovered in 1867 by Mormon farmers, who ran a tunnel into a body of soft, oxidized, ochery ore. This ore, though rich, was thrown over the dumps, only the nodules of galena being saved. In the year of its discovery the mine was bought by Bristol & Dagget for $15,000. In August, 1871, smelting was begun. The mine was sold in 1872 to an English company for $300,000 and 50,000 shares of the stock. Smelting proved so unprofitable that in 1875 it was abandoned and the ore sold. In 1876 the property was bought by an Amsterdam company. Smelting has never been resumed, though fairly successful attempts were made in 1877 to concentrate the ore by stamps, jigs, and shaking-tables. Leaching, both raw and after a chloridizing-roasting, was tried in 1878 with no success. Considerable prospecting was done in 1876, but since that time the mine has been worked most of the time on lease. The following table, showing the financial account of the mine, has been furnished by the superintendent. Some ore has doubtless escaped record. A small amount has been produced since 1878, but the figures could not be obtained:

Year.	Number of tons produced.	Per cent. lead.	Ounces of silver.	Cost of mining.	Cost of smelting.	Total cost, including salaries and expenses.	Value of product.	Profit.	Loss.	Total net profit.
Total	20,104.624					$967,042 66	$1,533,756 73	$577,107 02	$390 97	$576,716 05
1871	986.000	28.0	76.00			43,045 77	60,416 55	17,370 78		
1872	3,054.913	35.0	51.46	$23,490 17	$174,422 03	217,548 16	353,551 26	136,003 10		
1873	4,729.705	28.7	65.10	70,348 87	163,512 16	267,894 90	437,677 64	169,782 74		
1874	3,144.383	25.5	48.90	31,602 23	213,844 97	273,662 48	390,706 66	17,044 18		
1875	181.000	18.6	67.51	19,314 86	14,387 29	15,010 70	22,089 14	7,028 44		
1875	a2,345.860					42,818 54	119,250 50	76,432 96		
1876	2,022.891	28.0	52.50	25,745 52		47,906 41	157,946 02	109,979 61		
1877	1,972.253	15.0	62.60	16,580 23		35,043 62	78,509 14	43,466 12		
1878	916.750	21.7	51.30	3,042 50		14,662 10	12,661 73		390 97	

a Ore sold and not smelted.

This company owns adjacent properties, extensions, parallel veins, and stringers, as follows: Dixon, Dixon No. 3, Veto, Winnamuck, Winnamuck No. 2, Brilliant, Savage, Mountain Maid, Mineral Point, Torpedo, and Amason. These are mostly 1,500 by 200 feet each, and patented or patents applied for. They also own the Winnamuck placer claim in the bed of Bingham cañon and the Wasatch mine in Copper gulch. The Winnamuck vein is a contact vein between a black clay-shale hanging wall and a quartzite foot wall. The dip is 45° N.NE. The mine consists of one body or chimney extending from near the surface on the hillside to the pyrites near the level of the cañon, a distance of 460 feet. This body is from 100 to 300 feet long and from 1 to 18 feet (average 4½ feet) wide, and extends northwest in the vein diagonally between the dip and the strike. This ore is for the most part a soft, brown-yellow or gray siliceous ocher, containing horn-silver and cerussite. Some parts of the body assayed as high as $2,000 per ton. At about 150 feet above the water-line the ore changes from a "free" to a "base" ore, which has been worked to a depth of 85 feet, 100 feet long, and 4 feet wide. It still continues, but its grade is quite low. This lower part of the mine and the dump show large bodies of pyritous low-grade ore, containing galena, sphalerite, tetrahedrite, cubanite, and pyrargyrite, and assays about 15 ounces silver per ton. The gangue of the vein is clay and quartz, with some calcite and gypsum. In some unventilated parts of the mine, where the air was moist, an efflorescence of fibrous crystals of sulphate of zinc, sometimes 6 inches long, was formed on the hanging wall. At the southwest end of the ore body the vein was dislocated by a vertical fault and was thrown 28 feet NE. In some places the ore continues in the line of fault, but in the vein beyond it nothing has ever been found. The water level in this part of the mine was 130 feet above that at the ore body. A tunnel several hundred feet long has been run on the vein beyond the fault and a 60-foot body or dike of porphyry has been found. The water which enters near this from the hanging wall deposited thick coatings of sesquioxide of iron in the tunnel. This indicates a body of pyrites on the hanging-wall side. It was proposed to cross-cut at this point.

The developments consisted of a main tunnel 1,300 feet long on the vein about 40 feet above the bed of the cañon; three smaller tunnels and a vertical two-compartment shaft 240 feet deep through the hanging wall on the ravine side from about the level of the tunnel. The total length of drifts, shafts, and winzes on this and the smaller adjacent properties owned by the company was estimated at over 9,500 feet. The hoisting works, which had been idle for several years, consisted of a Cope and & Bacon vertical 30 horse-power engine, one horizontal boiler, 2-inch hemp rope, and a Blake steam-pump. During the census year a few men were employed in prospecting and on lease. The product was only two or three hundred tons. The old slag dump had also been leased at about one-quarter royalty, and produced 3 tons of scrap bullion, worth $200 per ton; 60 tons of matte, worth $62 per ton; and 40 tons of jigged material, worth $48 per ton. The results from this, as from most other old slag dumps, were not flattering to the early smelters.

The Dixon mine is on the opposite side of the ravine, and, as before stated, is owned by the same company. It has about 800 feet of openings, and is worked upon lease by a few men.

The Tiewaukee group consists of the Tiewaukee, 200 by 1,500 feet; Tilden, 200 by 960 feet; George, 100 by 2,400 feet; Ely, 100 by 2,400 feet; and the Surprise and the Lorenzo, which overlap the others; and is situated near the railroad station on the side of the steep ridge which forms the eastern side of the Main Bingham cañon. Ore was discovered in 1871, and work was prosecuted only at intervals until 1878, when the present body of ore was discovered. In August, 1879, the mine was bought by Mr. Goldberg. Troubles with adjacent claim owners gave rise to the consolidation in November, 1880, of all interests under the Tiewaukee Gold and Silver Mining Company. The property was worked steadily during the census year (Sundays excepted) by a force of fifteen men, who received from $2 50 to $3 per day. The total product prior to the census year was estimated at 1,200 tons, which were sold at about $100 per ton. In the year, 300 tons were extracted, which assayed about 95 ounces silver, 40 per cent. lead, and $12 gold. Ore of this grade was sold by sample (see description of sampling works) to the smelters for $80 per ton. The vein is a bedded vein in black quartzite, on the hanging-wall side of a belt supposed to be 250 feet wide. The strike is N. 28° E., and dip NW. about 38°. Its width is from 4 inches to 15 feet, with an average of 2 feet. The dip and strike are parallel to the hillside, and 75 feet from it. Near the summit there are large, prominent ocher-stained quartz croppings, in which some good ore was found. Little was known, however, of the vein beyond the workings, which extended 600 feet below the croppings. At this point, which is near the level of the ravine, a tunnel has been driven through the hanging wall cutting the vein. Drifts have been run on it 380 feet (showing ore, however, for but 200 feet), also short winzes and raises, in all 1,400 feet of cuttings. Although the ore was very moist, water had not been encountered. The largest body found to up date of the visit was lenticular in shape and 60 by 40 feet by 15 feet in size. The gangue of the vein is a very soft blue clay, with bands of quartz, in which binnite, pyrargyrite, zincblende, pyrite, galena, and sometimes native silver occur quite irregularly. On either side of the vein there is a 10-inch band of low-grade pyritous ore. For 60 feet from the croppings only ochery carbonates were found. At about 550 feet ruby silver and large quantities of zincblende appeared. The different minerals are in bands; ruby silver occurring on the foot wall, zincblende and pyrites in the center, and galena on the hanging wall. No faults have been found, but it was said that surface indications pointed to an extensive fault at a depth of from 200 to 300 feet. As to this the writer can express no opinion, as snow covered the hillside at the time of his visit.

The works of the New York and Utah Milling Company are located at Revere Switch, at the mouth of Bingham cañon, 5½ miles below Bingham. They were built in the summer of 1878 as leaching works for raw ore. About 400 tons of ore, principally from the Lucky Boy mine, assaying from 20 to 25 ounces, were leached, and yielded from 8 to 10 ounces per ton. The present company was organized in March, 1880. The works are intended to treat the "rebellious" silver and gold ores of Bingham, or sulphurets of iron, zinc, etc. (lead excepted); and at the time of the writer's visit were almost completed. They have cost to date about $30,000. The intended process is to roast and leach both the gold and silver. The company owns 5 acres of land and water rights, and have erected buildings containing a 40 horse-power engine, rotary drier, Howland crusher, one pulverizer, one Libsey single-stamp battery, one Brewster roasting furnace, and leaching vats. The Libsey stamp is an eastern invention (patented June 3, 1880). It consists of one 900-pound stamp, speed 120 drops per minute, and drop 5 inches; a pulley also gives it seventy-five revolutions per minute. The shoe and die are 15 inches in diameter, the feed being through an opening in the boss.

The Brewster furnace is a circular reverberatory roasting furnace, with rotary hearth. It had been tested for a year or more at Jersey City, New Jersey, on North Carolina gold sulphurets, and two others are in course of construction in that state. The furnace is 15 feet in diameter, the height 40 inches, and the walls are 30 inches thick. The hearth is covered with fire-brick. There are four stationary arms, from which prongs 2 inches apart extend to within a quarter of an inch of the hearth for the purpose of turning the ore. The arms and prongs are made of iron pipe and covered with fire-clay. There is a small fan blower to force air currents through these arms and prongs, which, impinging on the ore, will assist desulphurization and oxidation. The ore, salt, etc., are fed through holes in the roof of the furnace. The prongs are oblong, and, being set at an oblique angle to the radii, the furnace is self-discharging at the circumference. The time required to roast is said to be twenty minutes. One of these furnaces cost $6,000. No criticisms can rightfully be made at present upon the working of this new machinery upon the ores of the district. It was expected the works would be ready for operation by April 1, 1881.

The names, total length of openings, total product, and condition at the close of the census year of the mines of Lower Main Bingham cañon, other than those already described, are as follows:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Caledonia	2,100	$15,000	Being worked on lease	Ore sold at $75 per ton.
Occident	1,300	25,000	Active	Value of ore, $50 per ton.
Thrush	600	Small		Ore contains gold, silver, and but little lead.
Extension	500			Ore of low grade.
North Star	300			
Dial	400			
Elvina	350			Ore, $12 to $15 gold.

MINES OF PORCUPINE GULCH.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Live Pine Consolidated	2,650	$85,000	Active	The ore is galena, averaging 75 ounces silver and 30 per cent. lead.
Saint James	600	Nothing	Assessment work done	
Prince of Wales	300	do	do	
Irish-American Tunnel	890		do	Ore low-grade pyritous.
Silver Shield	840	$15,000		Assays: 25 per cent. lead; 50 ounces silver; $10 gold; 10 per cent. lead; 15 ounces silver; $4 gold.

MINES OF BEAR GULCH.

Litigation and the enormous amount of its purchase price have made the Old Telegraph group of mines the most noted in the West Mountain district. This property is situated 2 miles south of the town of Bingham, near the head of Bear Gulch, and on each side of it, and embraces the third west extension of the Telegraph, No You Don't, Nez Percés Chief, Grecian Bend, Roman Empire, Montana, Montreal, and other claims. They overlap one another to some considerable extent and, with the exception of the Montreal, are all patented. They became gradually consolidated by litigation and purchase until in 1877 or 1878 the name of Old Telegraph was given to the group. There was very little work done on any of these claims until 1873 and 1874, when Windsor & Randall bought the Nez Percés Chief and No You Don't, and organized a company in the East. An expert came out and took charge as superintendent, but as the mines did not prove profitable he returned. In the meantime (1873 to 1875) the Montreal company was running on a good body of ore. In 1874 a large body of ore was encountered in the No You Don't, and the former

superintendent returned and began tracing out the Montreal. The rival claims of these mines were litigated in 1877, and the No You Don't was successful. During 1877, and the preceding and the following year, there was the greatest output of ore. Suit was brought in the spring of 1878 by the old eastern company against its superintendent for alleged misrepresentation of facts in sending letters east stating that the mine was doing little, when it was in reality shipping large quantities of ore, and thus depreciating the market value of the stock then held, and purchasing it at a price very far below its real value. There were two trials. The first resulted in a verdict for the superintendent, and in the second the company was successful. Pending an appeal, the mine was sold to a French company, and a compromise of the suit was made, whereby the superintendent paid the company two hundred thousand dollars.

Current reports furnish the details of the placing of this property on the French market. The Old Telegraph group of mines, with the smelting and leaching works, were bonded to an individual for $1,000,000, who sold it to the French company for 17,000,000 francs. Previous to the sale, three reports were made upon the property, one by an American, and two by Continental engineers. One of the latter reported 1,500,000 tons above the 460-foot level, and as the vein grew wider, at least an equal amount below, in all, 3,000,000 tons; also, that the ore assayed 20 per cent. lead, and 40 ounces silver, and the pyrites 16 ounces silver and $10 gold. He estimated that 200 tons per day for 300 days, or 60,000 tons per year, could be worked; that the expenses per ton for mining and transporting would be $8 50; for leaching, $1; and for smelting, $4; and that the annual profits would be $1,600,000. He also suggested many ways in which the expenses might be decreased, such as roasting the pyrites from the mine, thus saving the purchase of iron flux, and selling the sulphuric acid produced.

The report of the other Continental engineer did not speak so definitely of the number of tons in sight, but estimated the profit on a daily yield of 100 tons at $805,000 per year.

The American engineer reported 30,000 tons in sight assaying from 15 to 20 ounces of silver, and that the mine was not worth over $1,000,000. In making his report he took forty-eight average samples from the mine, three of which assayed 21 ounces silver, and the others from 30 to 230 ounces per ton. He called attention to the fact that, notwithstanding these assays, the ore formerly sold had not yielded at that rate, nor had that which was worked daily, and that, in his opinion, the ore worked in the future would not yield at that rate.

The French capitalists preferred the French engineers' reports, and purchased the mines for the price above stated. The "Société des Mines d'Argent et Fonderies de Bingham" came into possession of the property on May 10, 1879, and ran both mines and furnaces until September 1, 1880, employing about 200 men. A few months previous to the writer's visit the mine was leased for two years. From five to fifteen men were employed.

The Old Telegraph group is located on a bedded vein or a mineral belt, in quartzite, from 20 to 250 feet wide, and dipping NW. 30°. This dip is quite irregular. The gangue of this belt is mostly a hard, tough, jointed quartzite, which is thoroughly impregnated with oxide of iron; but some strata of a soft, siliceous, granular material, evidently the result of the decomposition of siliceous limestone by acid formed from iron pyrites, and some clay and talcose clay are found. The vein had prominent ocher-stained quartz croppings on the summit of the ridge; but only came to the surface in a space a few feet square. The ore was of two kinds. On the foot-wall was cerussite and galena having a general width of from 6 to 26 feet. Occasionally it was much wider, one place showing 54 feet in width of square sets. An analysis of samples from 1,000 tons of this ore, made in 1876 by Otho Wuth, at Pittsburgh, is as follows:

	Per cent.
Carbonate of lead	50.43
Galena	15.02
Oxide of iron	3.78
Sulphide of copper	0.67
Sulphide of iron	7.37
Silica	12.47
Alumina	3.01
Carbonate of lime	3.64
Carbonate of magnesia	0.26
Sulphate of lime	3.04
Water	0.19
Silver (21.14 ounces—varies from 15 to 25)	0.0647
	99.94

Traces of antimony, arsenic, and cobalt.

On the hanging-wall side of this body of lead ore and adjacent to it was a belt of leaching ore from 6 to 16 feet in width. This was an extremely porous quartz of all shades of blue, white, and yellow, containing a small percentage of lead and from 10 to 80 ounces (average, 15 ounces) of silver. At times these ores shaded insensibly the one into the other. There were two enlargements of the vein, which formed great ore chambers several hundred feet below the croppings on the ridge. One of these was irregularly lenticular, with the following maximum dimensions: 250 feet long, 600 feet on the dip, and 60 feet wide. A portion of this body 100 feet long, 50 feet wide, and 50 feet deep, was solid galena.

The timbers of the square sets used were 10 inches square; posts, 6 feet 6 inches; caps, 4 feet 8 inches. These were cut in a saw-mill belonging to the company. One of the lessees stated that white pine mining timbers will last in this district five or six years, and quaking aspen ten years. In the spring the ground in this mine slips somewhat, and many of the timbers are crushed. In a few years the spaces from which the large bodies of ore were extracted will probably be filled by caves and slides. The mines were formerly developed by one incline 1,200 feet long through the ore body, and 1,000 feet on the strike, and by six tunnels and their drifts. The total openings were estimated at 3¼ miles. The large bodies of ore were about 180 feet from the hillside surface, and consequently were easily worked. A tunnel from the bed of the ravine on its eastern side, called the 460-foot level, was the lowest opening. This cut a body of pyritous ore (sulphides of iron, copper, and lead) 60 feet wide, which extended 30 feet above it. It also furnished drainage for a small amount of water.

On the opposite side of the ravine, in the Roman Empire and Grecian Bend claims, a body of carbonate ore was found. It was also lenticular in shape, being 100 feet long, 100 feet deep, and 20 feet thick. In the lowest tunnel in these claims there is a body of pyritous ore 131 feet across. The best portions of it will assay $10 silver, 10 to 15 per cent. lead, and $3 to $5 gold. At each end of this group of claims there was said to be a heavy porphyry dike, faulting and separating it from adjacent portions of the belt.

At the mine, and belonging to it, there are a large number of buildings, boarding-houses, offices, stables, saw-mill, leaching works, etc. The leaching works were built in 1877, and cost about $5,000. They consisted of a rock-breaker, a pulverizer, a revolving screen with a quarter-inch mesh, six ore vats 3 feet deep and 10 feet square, twelve precipitating vats, a large tank to hold the solution, a boiler, engine, and a rubber or wooden pump. These works were partially dismantled, but over 1,000 tons were treated in the few months during which they ran.

A narrow-gauge railroad or tramway 2½ miles long, with steep descending grade, runs between the mine and the depot of the Bingham Cañon railroad, thence 13½ miles to the extensive works on the Jordan river. The cost of transportation was $1 25 per ton.

During the census year about 12,000 tons (*a*) were extracted assaying 35 per cent. lead, 15 ounces silver, and $0 50 gold. Eighty men were employed at from $2 50 to $3 per day. The cost of extraction, including general expenses and superintendence, was about $10 25 per ton. The total product of this mine can never be known. The superintendent estimated it at 120,000 tons of all grades, but others thought this too high. Figures in the reports of the French experts, taken from the Old Telegraph books, show that from February, 1876, to November, 1878, 48,125 tons were extracted, valued at $1,129,660 58 (market price at the time). This was at the flood tide of the production.

The smelter was very complete, though from disuse it was somewhat out of repair at the time of examination. It was built in 1876 and 1877. Ore, coke, coal, and flux were dumped directly from freight cars into large bins, and taken thence in wheelbarrows to the feed floor. The plant consisted of a Blake rock-breaker, a sampling coffee mill, several platform and railroad scales, five water-jacket furnaces, a fan-blower, a No. 5 Baker blower, a No. 5 Root blower, flue-dust chambers, a large 65 horse-power engine, a turbine water-wheel supplied by a flume 12 miles long, a pair of Cornish rolls for matte, a small vertical matte-roasting furnace (not a success), a reverberatory matte-roasting furnace, and an old cupel furnace. The stack was of brick, square in section, and rested upon iron pillars from 5 to 10 feet in length. The crucible was of brick in an iron box 8 feet square. The jacket, composed of 8 cast-iron sections, rested on 6 inches of fire-brick. For 10 inches the jacket was vertical, and each side of the remaining 2 feet 8 inches had a batter of 11 inches. Each section was open at the top, and therefore had a free overflow. Sections were bolted together through lugs. Between the jacket and the stack there was an inch of fire-brick. The chimney was 40 inches square and 20 feet high, with cover. Each furnace was provided with a hood and siphon tap, or lead well. The flue-dust chamber for three stacks were of brick, 10 inches high and 20 inches square, resting upon a frame work about 15 inches above the ground. This chamber terminated on the lower side in four sheet-iron hoppers. The flue-dust which collected could thus be easily drawn off into cars.

The concentration works had been idle since the autumn of 1879, and were also somewhat out of repair. They consisted of Cornish rolls, four revolving screens, four jigs, one 5-stamp and two 10-stamp batteries, four revolving washing tables, 22 inches in diameter, on an incline of 10°, and a large number of tie-boxes.

The leaching works were built in the spring of 1878, and ran most of the time until the French company bought the property. They cost $16,000, and the plant consisted of a revolving screen, with quarter-inch mesh; a pair of Cornish rolls (*b*) of 20-inch face and 26-inch diameter; 10 ore vats, 12 by 14 by 3 feet; 20 precipitating tanks, 4 by 7 by 4 feet; and a pump. Power for this and the concentration works was furnished by a turbine wheel.

The ore was dumped from the railroad cars into smaller ones, which carried it to the revolving cylindrical screen. Whatever did not pass through the mesh passed on to the Cornish rolls. All the fine ore fell into a bin, from which it was taken in cars along a track over the ore vats, into which it was dumped. The ore vats were in two rows, between which ran a car into which the leached ore was shoveled. The vats had a false slat bottom, on which cocoa matting was laid. The precipitating tanks were on the outside of the rectangle, and were provided with several

a The actual amount of ore extracted was about 19,500 tons, but it was reduced by concentration to the 12,000 tons mentioned.
b One pair of shells of these rolls was said to have crushed 10,000 tons of this soft ore.

wooden faucets with which to draw off the liquor from above the precipitate. The sulphides were roasted on an open sheet-iron hearth and smelted in crucibles, or roasted and smelted in a cupel furnace. These works handled from 80 to 120 tons per day.

The ore of this mine was of three kinds—smelting, concentrating, and leaching. The concentrating ore was found to carry much of its silver as chloride, which floated off and was lost while jigging and tieing the lead ore. It was estimated that 12,000 ounces were thus lost each month. During the latter part of the time the ore was first leached and afterward concentrated, a loss of from 40 to 50 per cent. being thus avoided. At times a very elaborate set of assays were made. Unfortunately, the books containing them were not accessible, but the following are approximate data regarding the mode of working: At first the size of the coarsest fragments of the leached ore was one-quarter of an inch in diameter, but this was decreased to the size of wheat. From 2 to 6 ounces per ton were obtained by leaching. The concentrated ore assayed about from 15 to 20 ounces silver and 50 per cent. lead, and the tailings from the concentration works assayed about 4 per cent. lead and from 4 to 6 ounces silver. Ores from different parts of the mine required different times to leach, but the average time was 20 hours. Ore from an old dump of 1,000 tons, which had weathered for about a year, leached in twelve hours, 75 per cent. of the silver obtained leaching out in the first hour.

The method of using the solution was to pump the vats full, the liquid entering from the bottom and rising through the ore; then, after allowing the solution to stand 20 minutes, to open the discharge taps and allow them to run from twelve to twenty hours, until only a slight coloration was produced by the sulphide of soda, all the time keeping the vats full of the solution by pumping a fresh supply upon the surface; finally, to quietly flood with water (the water and hyposulphite not mixing) and drain off. This washed out the solution from the ore so that it was not wasted. The strength of the hyposulphite solution was kept at about half a pound to the gallon. The solution became weaker with use, and it was necessary to strengthen it by adding each week, in the case of free ore, about 25 pounds to the 8,000 gallons used, and in the case of base ore about 150 pounds. The leaching of the mass of the ore was about as close as the leaching of the assay samples. Sometimes 101 per cent. of the chloride assay value of the ore would be obtained in bullion. The bullion was from 0.900 to 0.990 (average 0.940) fine in silver, and from 0.001 to 0.004 (average 0.002) fine in gold, when free ores were treated. Toward the latter part of the time, when quite base ore was treated, the bullion was only about 0.500 fine in silver; the remainder lead, and some antimony; gold unknown. The sulphides from the leaching were usually mixed with lime and ocher slimes, and the adobes thus made were smelted in a blast furnace with ordinary charges. This was done because it was claimed that there was little loss of silver in smelting, and as much was received for it in the lead bars, and thus the express charges for the shipment of fine bullion were saved. The total amount of silver leached out was estimated at between 50,000 to 80,000 ounces. The cost of leaching at the mines was $1 10, but at the new works it was stated at only 20 cents per ton. The cost of concentrating was about 70 cents per ton.

The French company ran the concentrating works several months, trying the leaching apparatus occasionally, but their results were very unsatisfactory. Report says that they lost money from the commencement, and the products and expenses warrant such a conclusion. Their office force numbered 12 men, who received $2,600 per month. During the census year about 11,150 tons of ore were smelted (about 1,500 tons of which were purchased), which produced about 3,200 tons of base bullion, assaying 63 ounces silver per ton. An average of many partial analyses of Old Telegraph ore treated during the census year was:

	Per cent.
Lead	
Silica	(about).. 35.0
Lime	(about).. 38.0
Oxide of iron	2.0
Sulphur	6.0
Copper	2.5
Zinc	0.75
Antimony	0.1
Arsenic	0.05
	0.04

The cost of smelting was from $16 to $17 per ton, including everything. The amount of fuel to the smelting charge was about 14 per cent. Varying proportions of coke and charcoal were used. The iron flux was from 50 to 116 per cent. of the ore, and the limestone flux from 20 to 50 per cent. The minimum was 80 and the maximum 135 per cent. of both lime and iron flux. For several months the smelting charge averaged 11 per cent. of lead and 6 ounces of silver. The loss of lead was from 12 to 13 per cent., while that of silver and gold was claimed to be little or nothing. The matte contained from 6 to 7 ounces of silver, 9 per cent. lead, and some copper. It was usually a waste product. The slag assayed half an ounce of silver and 1 per cent. lead.

The other mines of Bear gulch are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Rough and Ready and Grand Cross.	.....	$10,000	Idle	Ore is low-grade carbonate and galena. Mine has several thousand feet of openings.
Victor	975	A few hundred tons	Active	Assays 10 ounces silver, 20 per cent. lead, $3 gold; 25 ounces silver, 50 per cent. lead, $4 gold.
Giant Chief	800	.....	.....	Considerable ore shipped some years ago.
Quaking Asp	350	.....	.....	
Eagle Bird	350	.....	.....	
Gray Eagle	950	.....	.....	Contains bodies of gold ore. Much lead shipped formerly.
Bazouk	400	.....	Idle	Some ore formerly shipped.
Abel Protector Tunnel	700	.....	Assessment work done	No ore of value.
Hamlin Mining Company	1,150	$20,000	Idle	Ore argentiferous cerusite and galena.

MINES OF MARKHAM'S GULCH.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Williams	700	.....	Active	Ore assays 25 ounces silver, 23 per cent. lead, $3 gold.
Old Stand By	400	$15,000	Idle	Vein is in quartzite, and is from 2 to 10 feet wide.
Colonel Sellers	300	.....	do	Vein 2 to 4 feet, assaying $20 gold per ton and upward.
Vespasian	900	.....	do	Some 35- to 50-ounce ore has been shipped.
Sacramento	500	5,000	.....	Ore of medium grade containing pyrites.
Columbia and Silver Hill	1,000	A few thousand dollars	.....	Vein 20 inches. Ore assays 10 to 20 ounces silver, 50 per cent. lead.

MINES OF MAIN CARR FORK.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
York	500	.....	Worked on lease	Several hundred feet of cuttings. Ore, medium grade of silver and lead.
Harriet Mining Company	740	.....	Active	Average assay of gold ore, $32 gold and $15 silver.
Omaha	400	.....	Assessment work done	Vein, 20 to 50 feet, containing gold ore.
Henry M	350	.....	.....	Vein, 25 to 30 feet; gold ore assaying $15 to $20 per ton.
Highland Boy	950	.....	Assessment work done	Assays: gold ore, $18 per ton; galena ore, 12 ounces silver, 50 per cent. lead.
Levant	a200	None	Idle	Vein, 8 to 12 feet of gold ore assaying $20 per ton.
Sunset	300	.....	.....	
Washington	400	.....	Idle	
Dora	350	.....	.....	
Frisco	b400	A few hundred tons of $35- to $40-ore.	Idle	Vein, 5 to 10 feet; ore, galena, and carbonate near the surface; pyrites at water line.

a Length of tunnel; other openings. b Total length of tunnels; also considerable drifting and stoping.

The Durant mill was erected in Main Carr Fork in the autumn of 1877 to concentrate low-grade lead ores, but was afterward changed to a gold mill. Every run has been a financial failure, partly because of the very low-grade ore worked. Attempts to concentrate the ore by passing battery sands through tie-boxes were a failure because too much pyrite was caught. It was a light 10-stamp mill with a small 12 horse-power horizontal engine and boiler, two jigs, a revolving screen, and some tie-boxes, and cost $8,000. It had been idle, with the exception of a few weeks' run, for two years.

MINES OF COTTONWOOD FORK OF CARR FORK.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Arrowpoint	1,050	$20,000	Worked on lease	Vein 4 feet, mainly soft ochery low-grade jigging ore; also lenticular bodies of ore assaying 20 ounces silver, 50 per cent. lead, and $4 gold.
I. X. L	750	.....	.....	Vein, 2 to 10 feet. Ore assays 20 ounces silver, 40 per cent. lead, and $5 gold, or $27 per ton.
Venice	315	.....	.....	Vein, 1 inch to 1 foot.
Knickerbocker	800	.....	Idle	
Blue Jay and Green Grove	400	.....	.....	Ore assays 28 ounces silver and 58 per cent. lead.
Jersey Blue	350	16,000	Active	Vein, 20 inches to 5 feet. Ore assays 80 ounces silver, 40 per cent. lead.

MINES OF SAP GULCH.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Yampa No. 1	525		Active	Tunnel has not cut the vein.
Yampa No. 2	440		Idle	Vein 50 feet, containing large bodies of soft, red ocher, assaying $10 gold per ton.
Overland	300			A large body of gold ore, said to average $15 to $25 per ton.
Agnes	610	$25,000		Vein 6 feet. Ore high-grade lead and silver 3 inches to 1 foot on foot wall.
Mormon Heel	600			Gold ore on hanging wall. In one place vein said to be 38 feet, averaging $10 per ton.

MINES OF LOG FORK OF CARR FORK.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Elephant	350		Active	Vein 2½ feet. Ore is galena and cerussite.
Bonham	900	$600	Idle	Vein 75 feet. Ore low-grade gold.
Sacred	750		do	Vein 5 feet. Ore high-grade lead and silver, $50 per ton.

MINES OF MUDDY FORK OF CARR FORK.

The Stewart Mining Company was incorporated in 1878, with a capital stock of $600,000 in 60,000 shares. The company owns the following claims: Stewart, Washington, Saratoga, and Bulldoser, which are patented; Constitution, Bobtail, Apex, Mill City, Golden Crown, Phœnix, Casco, and others, not patented; most of them are situated on a high, steep ridge which separates Main Bingham cañon from Muddy fork.

The Saratoga, Bulldoser, and Constitution had each 500 feet or more of drifts, shafts, and tunnels. They had been comparatively idle for two years, and had shipped little or no gold ore.

The Stewart is the principal mine of the group. It was discovered in early times, and was worked as a lead mine. About 100 tons of low-grade gold, silver, and lead ores were extracted from bodies found near the surface. In July, 1878, the mass of porous ocher-stained ore was first found to contain gold in paying quantities. In general little was known of this mine, the size of its veins, or the dimensions of its ore bodies, excepting that it had near the surface an immense body of low-grade gold ore, rich in places. This body appeared to lie between quartzite walls (strongly stained with iron oxide near the ore) with a dip NW. 30°. Its size was unknown. Developments showed its greatest dimensions to be from 50 to 200 feet wide, 300 feet deep, and 400 feet long. The ore is a very porous quartzite with bodies of fine quartz crystals. The whole mass is permeated by clay and is strongly stained with oxide of iron, which gives it a brownish-red color. About three-quarters of the ore is soft and fine, being only held in place near the drifts by the clay contained in it. Occasionally there are seams of a silky talcose clay, from a half-inch to 3 inches wide. This generally assayed from $50 to over $100 in gold. Except in the spring of the year, when the snow is melting, the mine is dry. In one spot water is found, with some galena, pyrites, and blende ore; but the dry workings extend below this. The mine was developed by several tunnels, from which many drifts, cross-cuts, and winzes had been driven in exploring the body. The office map showed 3,840 feet of cuttings, but only one-half the work was said to have been plotted. Very little powder or timber was used in the mine. In one place some square sets were put in, but the ground caved to the surface, leaving a small crater-like opening. The cost of timbering alone in working these large bodies of low-grade gold ore greatly diminishes the percentage of profits. The ore was taken in the mine cars and dumped through a chute into ore bins in the company's mill in the ravine below.

During the census year, an average of sixty-four miners were employed. The shifts were ten hours and the wages from $2 50 to $3 per day. After the mill shut down there were only a few men engaged in prospecting. The total yield of the mine to the date of the writer's visit was estimated at about 17,000 tons of ore, and the assay value of the bullion was $172,825 21. The remaining claims are gold prospects upon which little work had been done.

In the autumn of 1878 Eagan & Bates' 10-stamp mill was removed from Main Bingham cañon and erected on the Stewart mine. Ten additional stamps were added in January, 1879, making the total cost of the mill $25,000. It ran steadily until May 1, 1880, and has, for some unknown reason, been idle since. The officers said it would start again early in the spring of 1881. The mill machinery consisted of a 60 horse-power engine; a boiler, 16 feet by 60 inches; a Blake plaster-crusher, 12 by 16 inches; 20 650-pound and 750-pound stamps, speed 90, drop from 7 to 9 inches, single discharge; Russia iron No. 6 slot-screen; 2 Tulloch and 2 Hendy self-feeders; and aprons with amalgamated copper plates. The capacity of the mill was about 50 tons per day. The labor employed in 24 hours was: Two amalgamators, four feeders, two engineers, one carpenter, and one rock-breaker man. Wages were

from $3 to $3 50 per day. In the first eleven months of the census year 10,000 tons of ore were milled at a cost of between $2 and $3 per ton. The product was $99,267 37 cash received for bullion. The ore averaged about $11 in gold. There was also some silver. Tailings averaged about $1 50 in gold. The fineness of bullion was 0.900 gold, 0.060 silver, and 0.040 copper. The mortars were 13 inches in width at the bottom, and the new die surface was 4 inches below the discharge edge of the screen. The quantity of water fed to the batteries was such that the stamps in their highest position never rose above it and splashed, but swashed it from end to end of the mortars in regular waves. The order of the stamp drop was 1—5—2—4—3. Two of the mortars had copper plates on the back side, but amalgamation in battery was also practiced in the other two. Quicksilver was added every thirty to sixty minutes, according to the usual rule. One-half or two-thirds of the total amalgam was caught in the mortars, the copper plates not seeming to greatly affect the quantity so caught. The screens lasted twenty days. Shoes and dies were of iron and lasted from thirty to forty days. The shoes and dies wore very irregularly concave and convex. The loss of iron per ton of ore crushed was about 1½ pounds. The copper plates upon the aprons below the mortars were 4 feet long and had a fall of 2 inches in 1 foot. Two of the mortars had four plates 30 inches wide, and at the lower edge a riffle one-half inch deep and three-fourths of an inch wide to catch any mercury or amalgam that might be carried down. The other two aprons had one plate 30 inches wide, and six plates 15 inches wide, but no riffles, thus giving, as before, 10 feet of amalgamated plate surface. The aprons were a single frame so arranged that its grade might be easily changed in case ochery or pyritous ore was being milled. There were some silver-plated copper plates which did not work satisfactorily. They began to act more quickly than new copper plates, but were too hard. It was thought that gold-plated copper plates would serve the purpose better. The copper plates in use would assay $1 per pound in gold. Below the aprons were troughs containing riffles, which emptied into a small box. But 5 pounds of mercury was caught here in two or three months. The loss of mercury, from actual weighings, was said to be something less than one-twentieth of a pound per ton of ore.

The method of assaying for gold was as follows: Shovel samples were taken every half hour from the self-feeders, which, when broken, quartered, and pulverized, made a 24-hour sample. Tailings samples were taken every hour from the end of the sluice. These also made a 24-hour sample. Four assays, of 1 ounce each, were made in the crucible, a small piece of pure silver being added.

The Last Chance mine was discovered in 1869 or 1870. It was sold to an English company for £100,000, part in stock. Work commenced in 1872 and continued until 1877, in which year it was leased. In May, 1878, the putting in of machinery was begun. After pumping water for some time, the mine was shut down in the autumn of 1879 on account of the money being exhausted and the inadequate power of the machinery, and has been idle since. Pyrites were encountered at the water level. During the first few years of operations the company ran the smelter at Sandy, now known as the Flagstaff, on their ore. Afterward the ore was sold in the Salt Lake market. The total product of the mine was between $400,000 and $500,000 currency received. It was said that $75,000 was paid in dividends. The claim has been developed 955 feet on the dip and 950 feet horizontally. It was opened by an incline through the ore body and two tunnels through the foot wall of the vein. In the lower tunnel, which is 820 feet long, and on the 700-foot level, an engine was set, and the incline was sunk 255 feet. The total length of shafts, levels, and winzes was about 6,100 feet.

The other mines of Muddy Fork of Carr Fork are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Mineral Point Company				Comprises seven claims; little work has been done.
Edison	1,420		Idle	No ore ever shipped.
Hooper	400			Vein, wide; ore, low grade.
Last Chance No. 2	1,200	Many thousand dollars.	Worked on lease	Ore, high-grade silver and lead, with some gold; 100 tons yielded $3 50 per ton.
Peabody	500			
Saginaw Mining Company	3,500	$30,000	Idle	
Cresus	1,200	Many hundred tons.	Worked on lease	Vein, 2 to 4 feet; ore assays, 30 to 60 ounces silver, 20 to 40 per cent. lead, and $12 gold.
Nast	1,000		do	Annual product, 50 tons, $47 ore; vein, 12 inches (under water).
Saturn	800		do	Has yielded considerable lead ore.
British Flag	400		Idle	Has produced some 40-ounce ore.
Glasgow Company	2,500	$25,000	Worked on lease	
Benton	900	8,500		Vein, 5 feet; ore, lead, silver, and gold; value, $40 per ton.
Centennial	500			A small amount of ore shipped.

MINES OF ROSS FORK.

The Bevan Mining company owns a 10-stamp gold mill and a group of gold mines adjacent to and northeast of those of the Stewart company. The claims are: Stewart No. 2, Stewart Fractional No. 2, Ingersoll, Osage, and Wedge, none of which are patented. The mines were discovered in 1879, and the company was organized in July of the same year. A large amount of prospecting was done in the mine, and it was bonded to New York men until October, 1880. They failed, however, to take it, and the property had been idle for six months previous to the writer's visit. Only one mine, the Stewart No. 2, was developed to any extent. It was opened by two tunnels through the hanging wall, 250 and 450 feet long. About 3,500 feet of drifts, cross-cuts, and winzes have been driven. These show a body of ore from 4 to 15 feet in width, 160 feet in length, and extending, from 60 feet below the surface, 140 feet on the dip. These dimensions are those of the workings, the limits of the ore body being unknown. The dip is NW. 35°. No water or pyrites have been found in the mine. The ore is similar to that in the Stewart, but much more friable, and consists of a mass of small imperfect crystals or grains of quartz, very slightly cemented together by clay, and the whole strongly stained with oxide of iron. Seams of a white, silky, talcose clay are frequently found, and are uniformly rich. The ore is very much spotted, and assays from $2 to $60 in gold. There is no possible way of distinguishing between the rich and the poor ore as it occurs in the mine. Some carries quite coarse gold, and all considerable silver. The gold is said to be free and to amalgamate quite well. To the east of this body, and separated from it by 30 feet of quartzite country rock, or a horse, a second large vein has been found, but has not been drifted upon. The ore is similar, but of somewhat lower grade.

The company's 10-stamp mill, located on Carr Fork, three-quarters of a mile from the mine, was erected in July, 1879, and ran at intervals during the autumn, winter, and following spring. About 1,500 tons were crushed, from which $20,000 were obtained. It is said that the gold was free and easily caught, but that several dollars per ton in silver were lost. Accurate information regarding the milling results was not obtainable.

The Essex Mining Company owns four gold prospects—the Essex, Chicago, Argonaut, and Parker. It is reported that there is a 10-foot vein of $12 gold ore. There are about 400 feet of tunnels. Six men were employed during a greater part of the year.

COPPER MINES OF BINGHAM.

Above the town, about half-way up the cañon, is a copper belt, the veins of which run nearly at right angles to the silver veins of the district. The principal claims are the What Cheer, Hickman, Murphy, Kingston, and Washington. They are all small veins in quartzite, from 3 inches to 4 feet wide, containing azurite and malachite at the surface, and sulphides of copper and iron at the water line. Traces of silver and gold are also found.

The What Cheer was located in 1873, and was worked for two years; only assessment work has been done since. The vein, from 3 to 4 feet wide, assayed in places from 10 to 12 per cent. copper. A four-stamp mill was erected in 1874, but the ore could only be concentrated to 20 per cent. A 300-foot shaft and 200 feet of other cuttings constituted the developments. Considerable ore and concentrations were shipped.

The Hickman Lode has 300 feet of tunnels. From the surface deposits $6,000 worth of copper ore was reported to have been collected.

On the Murphy mine is a 170-foot tunnel, showing a 3- to 10-inch vein, and a few feet outside of it impregnations of black sulphide and carbonate. Some jigs, erected for the purpose, failed to concentrate the ore.

Below the place where the copper belt crosses the cañon, the water which runs or percolates along the bed-rock contains a small percentage of blue and green vitriol in solution, resulting from the oxidation of copper and iron pyrites. In placer mining fragments and nuggets of copper are found, especially in alluvial soil and among partially decayed twigs and roots, where organic matter has precipitated it. So strongly is the water impregnated with this metal that picks and shovels immersed in it instantly become reddened from the deposit. No attempt has been made to save the very considerable quantity of copper daily running down the cañon.

GOLD PLACERS OF BINGHAM.

The placers of Bingham are the only profitable ones in the territory. They were discovered in 1864, though little was done until the winter of 1867–'68. From that time until 1872 and 1873 they were worked vigorously, but since then only in a small way. There are two placer-mining districts in the cañon, the upper and the lower. Each has a recorder, and contains a limited number of claims in the bed of the ravines. About twenty men are employed during about half the year, and collect about $20,000. The gold is coarse, from half an ounce downward. One nugget, however, was found in 1878 valued at $118. The fineness averages about 0.852 gold and 0.140 silver. The total gold-dust product of the district is unknown. In 1872 Mr. J. R. Murphy estimated it at $1,000,000. Mr. B. A. M. Froisett placed it, June 30, 1874, at $1,673,265. Old residents and storekeepers estimate it from a million to a million and a half. The greater portion of the gold has been extracted in the neighborhood of the town of Bingham by drifting in benches on the side of the ravine, remnants of the old channel, from 25 to 150 feet above the present one. About 1871 or 1872 some hydraulic mining on a small scale was tried, but without success. In 1878 the Argonaut Gold Mining Company, incorporated in New York, made another attempt. They bought 160

acres having a 40- to 70-foot bank, and used 300 or 400 inches of water. They had worked about an acre and a half up to October, 1880, when they failed, having obtained but little dust. The gold is within 3 or 4 feet of the bed-rock. Part of the ground was drifted on in early times, and produced over $100,000.

The bed of Main Bingham cañon is supposed to be very rich. Near the town, where the ravine is narrow and steep, two long tunnels have been run through the gravel to drain and work the bed-rock. One worked from 1870 to 1874 was 1,000 feet long. It ran up both Carr fork and Bingham, and paid well. The present one is 1,500 feet long. Every 250 feet a shaft is sunk through the 60 feet of overlying *débris*. The gravel drifted out is washed in sluices on the surface. The pay is found within 5 feet of the bed-rock, covered by a stratum of cement an inch or two thick. The channel here is about 60 feet wide, and though rather spotted, owing to its steep grade, has paid good wages. The cañon bed below this is covered by the placer claims of the Winnamuck company; Clay & Walker, 200 by 4,700 feet; Watson & Ireland, 400 by 4,200 feet, and others. Many attempts have been made in the lower part of the cañon to reach the bed-rock, which is supposed to be 100 feet below the surface, but the small pumps used could not control the water. A tunnel from 2,000 to 3,000 feet long will probably be necessary.

MINES OF BARNEY'S CAÑON.

Gold was first discovered in Barney's cañon in 1878. There are perhaps 30 claims. The veins are between limestone hanging and quartzite foot walls, and are supposed to be continuations of the gold belt in Carr fork. They are 20 feet wide and upward, and carry from 6 to 8 feet of $15 to $30 ore. The principal prospects are the Salt Lake and the Cave. The former has 250 feet of openings.

MINES OF COPPER GULCH.

The Lead mine was discovered in 1871, and was relocated in 1875 by the Yosemite company. It has been worked by its owners almost continuously since its relocation. It was purchased by the Lead Mine Company in the spring of 1880. Two parallel adjacent claims, the Carbonate and the Chloride, are included in the property. The developments extend 400 feet on the dip, 300 feet in length, 200 feet in width, and indicate a large bedded vein or mineral belt, dipping N.NW. 50° between quartzite walls. The ore, in a wedge-shaped mass, came within 4 feet of the surface. All between the walls (the only partial cross-cut shows 150 feet of ledge matter) was ore of the same grade, which consisted of a light-brown, granular, and crystallized cerussite (locally called "crystallized lead") mixed with small angular fragments of quartz. In about the center of the mass, dipping irregularly 45° SW., was a body or chimney of clear cerussite 10 inches square. Branching from this, and in all parts of the mine, occur bodies and stringers of the clean ore, from a few inches to a few feet in width. The clean or first-class ore is shipped, and averages from 48 to 58 (average 50) per cent. lead and 7 ounces silver. The second-class ore was piled upon the dump to await the erection of concentration works the next season. The waste dump was very small, but 75 feet of drift having been run in country rock. No water was encountered. The mine was opened by a vertical 200-foot shaft and two inclines. The total amount of drifts, shafts, and winzes is 1,120 feet, not including old upper works partially filled. A Copeland & Bacon 40 horse-power engine had just been placed in position, and was supposed to be able to sink to a depth of 1,000 feet. About twenty men were employed. During the census year 1,500 tons of first-class ore were sold at the rate of about $18 per ton. In addition to this 2,500 tons of second-class ore were produced. Transportation, 12 miles to Sandy, cost $2 50 per ton. The total product of the mine to June 1, 1880, was estimated at 4,500 tons of first-class ore, which sold for about $81,000 in coin, and 10,000 tons of second-class ore, which it was intended to concentrate by stamps, riddles, and tie-boxes.

The other mines of Copper gulch are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Wasatch and Olympia	1,010	Estimated at 4,000 to 10,000 tons.	Worked on lease	Vein, 60 feet; ore, carbonate of lead; assays 6 to 50 ounces (average, 10 ounces) silver, 35 to 60 (average, 45) per cent. lead.
Miner's Dream and Vanderbilt	2,000	$80,000	do	Vein, 5 to 15 feet. The first-class ore is carbonate of lead, and assays 30 to 55 per cent. lead, 12 to 17 ounces silver, and $3 to $10 gold. Also much low-grade ore.
Mayflower	2,500	52,000	Idle	Vein, 15 feet. First ore assayed $15 to $300, one-third of which was gold. Pyrites encountered at water level.
Evergreen	400	15,000	do	Vein, 1 inch to 2 feet. Assays 90 ounces silver, $12 to $20 gold, 35 per cent. iron.
Union Flag	800			Similar to Evergreen and Union Flag; supposed to be the same vein. Some ore extracted, but none shipped.
Yosemite No. 2	1,350			Greatest width of vein 10 feet; ore assays 10 ounces silver and 50 per cent. lead. Several hundred tons have been shipped.

MINES OF BUTTERFIELD CAÑON.

The Yosemite mine was discovered in 1866. Little work was done until 1870. The mine was worked vigorously during 1874, 1875, 1876, and 1878, at times as many as one hundred and fifty men being employed. During the census year but eighteen were at work, and at the date of the writer's visit a less number, owing to the state of the mine and the low price of lead. The vein is near the summit of the high steep ridge which separates Butterfield cañon from both Copper gulch and Bingham cañon. It is 16 miles west of Sandy, on the Utah Southern railroad. The cost of transportation is $4 per ton. The ore-bearing formation is a bedded vein from 6 inches to 30 feet (average, 4 feet) wide, in quartzite, dipping NW. 45° to 55°. The ore outcrops at the surface in places for several hundred feet, and usually occurs on the foot wall. One chute was found from 20 to 60 feet long, and from 5 to 25 feet (average, 7 feet) wide, extending from the surface to a depth of 500 feet. Another body of very clean carbonate ore began 160 feet from the surface and extended 100 feet, being 6 feet wide and 50 feet long. Various other small bodies have been found. The gangue of the vein is composed of quartz, clay, and talcose clay, stained with oxide of iron above the water line, or 450-foot level. The country rock is very seamy and quite soft in the vicinity of the vein. The ore is principally cerussite with some galena, associated with ocher, quartz, and clay. It assays from 45 to 70 per cent. lead, from 11 to 24 ounces silver, and a trace of gold. Below the water line, and in bunches far above it, the ore is composed of pyrite, chalcopyrite, galenite, and sphalerite. These pyrites sometimes assay $12 silver. The mine is opened to a depth of 600 feet by an incline 6 by 6 feet, and elsewhere by a 600-foot tunnel, 4½ by 7 feet. The extreme horizontal extent of the workings is about 1,500 feet, and the total length of levels, shafts, and winzes in the neighborhood of 6,000 feet, 1,200 feet, and 2,000 feet, respectively. The machinery consists of a 35 horse-power horizontal engine and boiler, a half-inch steel wire rope, and a No. 7 Blake pump. When the pump was used, the flow of water was estimated at 2,000 gallons per hour. The hoisting plant cost $6,000, and is thought to be capable of sinking to a depth of 1,000 feet. During the census year the output was about 1,800 tons, assaying from 12 to 16 ounces silver, and from 55 to 60 per cent. lead. The ore sold for about $21 per ton. The total product to September 1, 1880, was estimated at 25,000 tons, which sold for $750,000. There was also a large dump, containing several thousand tons of second-class ore, assaying from 7 to 22 per cent. lead, and from 6 to 8 ounces silver.

The old Revere concentrating works were erected in 1875 or 1876, and consisted of a 20-stamp mill, tie-boxes, and tossing tubs. They were bought, torn down, and rebuilt by the Union Ore Concentrating Company, of New York city. The new works were completed in June, 1880. They ran until August, and have been idle since. The cause of this idleness was said to be the increased price charged by the mine owners for the low-grade ore of their waste dumps. The works are situated in Butterfield cañon, 1 mile from its mouth, and 2 or 3 miles from the low-grade ore on the ridge above. They are in an imposing three-story building, and are said to have cost about $60,000. Their capacity is 2½ tons per hour, but it is probable that were the crushing apparatus increased this could be doubled. Eight men per shift are required. The machinery consists of a Leffel turbine wheel, an Ames 40 horse-power engine, a Blake rock-breaker, a rotary drier, 3 feet by 30 feet; three sets of Cornish rolls, several reels and screens for sizing the ore, two double water jigs, two single water jigs, six Paddock's pneumatic jigs (used after sizing through screens Nos. 60, 80, 100, and 120), a belt machine or vanner for the very fine dust, and a tossing-tub. Good results were obtained from the waste dumps of some of the neighboring mines, especially where the ore was an ocher and a carbonate of lead. This class of ores assayed from 6 to 8 per cent. lead, and from 7 to 8 ounces silver, and they were concentrated to 50 per cent. lead, and from 15 to 25 ounces silver. Ten tons of ore from the Carbonate mine, in Beaver county, assaying 18 per cent. lead and 40 ounces silver, were concentrated to 63 per cent. lead and 200 ounces silver. Attempts, however, to separate galena, pyrite, and blende were not so successful. Careful weighings, samplings, and assays were made during the short run, but the results were not accessible.

The Holt concentrating works were erected in the spring of 1880 at the mouth of Butterfield cañon. They had a 6 horse-power engine, a revolving screen, four jigs, and four tie-boxes. They worked two months, during the year preceding the writer's visit, on waste-dump material from the Wasatch and Yosemite mines, assaying from 12 to 20 per cent. lead and from 5 to 9 ounces silver. Concentrations (about 1 to 3½) assayed 55 per cent. lead, 14 ounces silver, and $4 gold.

The other mines of Butterfield cañon and its adjacent gulches are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Revere	5,000	$300,000	Idle	Ore assays: first-class, 15 ounces silver, 45 per cent. lead; low-grade, 10 ounces silver, 15 per cent. lead.
Telegraph	550		Active	Vein, 5 feet to 6 feet between limestone foot and quartzite hanging walls.
First W. Extension Telegraph.	1,030	2,000	do	Ore assays 44 to 56 per cent. lead, $5 to $13 silver, $1 to $3 gold.
Summit (a)	215		do	Vein, 8 to 12 inches; ore averages 60 ounces silver.
Liberty (a)	145		do	
Red Cloud (a)				
Chubb (a)				
Experiment (a)	900	125 tons	Active	Vein, 3 feet; ore, one-half inch to 7 inches, assays 12 ounces silver, 36 per cent. lead, $3 gold.
Queen and Bemis (a)	515	160 tons	do	Average assays, 65 ounces silver, 4½ per cent. lead, and $5 gold.
Lucky Boy	1,200		do	Vein, 6 feet, containing 6 to 30 inches sulphuretted ore.
Hiatt	1,000	150 tons	Idle	Ore assays 23 ounces silver, 9 per cent. lead, and $5 gold.
S. and S	900		Assessment work done	A few thousand dollars' worth of ore shipped formerly.
Barstow	400			A small amount of ore shipped formerly.
Happy Go Lucky	220			Ore, silver and lead.
Badger	220			Do.

a Owned by Northern Chief Mining Company.

MINES OF SPRING GULCH.

There are a number of prospects in this gulch, the principal one of which is the Black Metallic. This mine was sold for $20,000. The vein, from 4 to 9 feet, is in quartzite, and carries 3 feet of ore. Assays of a few tons assayed averaged $30 silver, $11 50 gold, and 17 per cent. copper. It has been idle for some time.

LITTLE COTTONWOOD MINING DISTRICT.

[October, 1880.]

The Little Cottonwood mining district is at the head of Little Cottonwood cañon, near the summit of the Wasatch range. Mineral was first discovered by soldiers in 1864 and the Wasatch district was organized, but soon abandoned owing to the great expense of working. In 1867 most of the claims were jumped and a new district organized called the Mountain Lake, which included a large area of country in the Wasatch range. It was divided in 1869 and 1870 into Big and Little Cottonwood, American Fork, and Uintah districts.

The Little Cottonwood district records show about 3,500 locations, of which probably not more than 400 are still held. These claims are situated in an area 2½ miles square. They are on precipitous hillsides and ridges, which rise from the bed of the cañon to summits from 10,000 to 12,000 feet above sea level. The formation is Carboniferous limestone (*a*) underlaid by quartzite, schist, and granite. The mines, with few exceptions, are in the limestone. The district is connected with the Utah Southern railroad at Sandy by the Wasatch and Jordan Valley railroad and tramway, 18 miles in length. The rise between Sandy and Alta, the terminal points, is 4,536½ feet. The freight rates at the time of the writer's visit were as follows:

	Per ton.
Ore assaying over 30 ounces	$4 00
Ore assaying between 30 and 15 ounces	3 50
Ore assaying less than 15 ounces	2 75
Granite	1 00

During the census year 6,343$\frac{999}{1000}$ tons of ore were shipped by this road; also 5,385 tons of granite for the Mormon temple at Salt Lake City. Owing to the great depth of the snow in winter (from 6 to 15 feet) several miles of the Alta end of the tramway is protected by sheds. These are frequently swept away by snow-slides and the road is temporarily blocked. The railroad was completed in May, 1873, and the tramway in 1875 or 1876. The district was very dull at the time of the writer's visit. But two mines, the Vallejo and the City Rock, were working regularly, and but few companies were driving long tunnels to cut their veins at any considerable depth; the others were idle or leased. This state of things was due to legal troubles, the exhaustion of the working capital of several large prospecting companies, the giving out of surface bodies, the finding of pyrite and water in the lower levels, and the low price of lead. Very little metallurgical work had been done in the district, as most of the ore was sold in the Salt Lake market. In 1866 the owner of the North Star mine built a Scotch hearth furnace, and ran out about 3 tons of lead. In the following year he erected a reverberatory and a cupel furnace. The former was a success, but the latter failed. The Jones smelter was built at the mouth of the cañon in 1871 or 1872, and ran on custom ores for two years. In 1872 or 1873 the Davenport smelter was started at the same place. In addition to that from the

a Exploration Fortieth Parallel, Vol. II, p. 343.

mine, it worked some custom ore, but was shut down in 1875. The Flagstaff company also erected three stacks in this vicinity; several unsuccessful attempts were made to leach ores on a small scale. Concentration works were built for the Emma mine, which were financially successful, though the percentage obtained was low.

The Emma mine is situated half-way up the southern slope of a high steep ridge called Emma hill. It was located in 1868 by Woodman, Chrisholm, Woodhull & Reich. Little work was done until the autumn of 1869, when the ore body was struck. Some ore was shipped and sold prior to the sale of the mine to the Emma Mining Company, of New York, in 1870. This company worked the mine quite vigorously, and shipped a large amount of ore. The following year the property was sold to the Emma Silver Mining Company of Utah (limited) for $5,000,000 cash; another authority placed the price at $3,500,000. The mine was then worked by English managers, paid $300,000 in dividends (one authority says $1,300,000) until September, 1874, when it was attached by T. W. Park and others for an indebtedness of $300,000. It was then idle until October, 1877, when the American Emma Mining Company was incorporated and work resumed. (a) The second ore body failed in the autumn of 1873, up to which time most of the ore had been shipped to Swansea, Wales. During the years 1873, 1874, 1878, and 1879 much low-grade ore was concentrated by jigs.

When the American Emma company began work it first prospected the old ore bodies, and then leased the Bay City tunnel, which was 1,700 feet long, and 90 feet below the lowest old workings of the Emma. This tunnel had been run by a Saint Louis company at a cost of $75,000, and had been abandoned in 1876. Since making the connection, a small ocher-stained seam, in an incline or winze 130 feet below the tunnel level, has been followed. At the mouth of the tunnel are two horizontal boilers, 14 feet by 40 inches, and two Clayton No. 2½ air-compressors. These force the compressed air through a 4-inch galvanized iron pipe, warranted to stand a pressure of 150 pounds, 1,800 feet, to an 8 horse-power engine over the winze, and a Knowles No. 7 pump. The pressure of air is kept at 60 pounds. About 3,500 gallons of water per hour is raised. During the census year about fourteen men were employed. The property of this company consists of the Emma, 2,400 by 100 feet, and the Cincinnati, 1,200 by 100 feet. One hundred thousand dollars was paid for the latter, but the claim having been jumped, the title is in dispute. The ore-bearing formation is a belt of siliceous limestone, between a limestone hanging and a dolomite foot wall, the belt being about 200 feet wide, dipping 45° NE. parallel to the stratification of the country rock. The ore did not come to the surface, but was found by following a small seam of ocher 50 feet in a tunnel. Two large bodies were found somewhat nearer to the hanging than to the foot wall, following the general dip and strike of the belt. One began near the surface, and was 100 feet deep, 300 feet long, and from 1 to 30 feet wide; and the other, a few feet below the first, was 200 feet long, 150 feet deep, and from 1 to 20 feet wide. The ore was a soft brownish-red ocher, containing cerussite, anglesite, galena, and some manganese oxide. During the census year 778 tons were obtained by chloriders and from jigs, which sold for $55,071 54. From Mr. Charles Smith, of Salt Lake City, whose accounts included all but the first few hundred tons sold, the writer learned that the sales of ore to June 1, 1880, amounted to 27,451 tons, for which $2,637,727 44 was received. The mine had been developed below the discovery only about 500 feet vertically and 350 feet horizontally. The openings of the old workings were estimated at something less than 4,000 feet, and those of the new workings at about 700 feet.

The Flagstaff mine is situated a quarter of a mile north of Alta, half way up the southern slope of a high ridge which separates Big from Little Cottonwood cañon, from 700 to 800 feet above the valley. It was located in 1879 by Grosbeck, Schneider, and others, who worked it under the name of the Salt Lake Mining Company until February, 1872, when it was bonded to one Davis for $300,000, who sold it to English capitalists for $1,500,000. They organized the Flagstaff Silver Mining Company of Utah (limited), and worked the mine in a very expensive manner until December, 1873, when the ore bodies in sight gave out. The company was then found to be in debt to Davis, for money advanced, some three hundred thousand dollars. Davis took the mine and worked it under agreement with the company until December 24, 1876, when he was dispossessed by the United States marshal under orders from the English directors. Heavy lawsuits with small results followed. Since 1876 the mine has been leased and subleased many times, but has been idle since the summer of 1880. At the time of examination it was owned by Seligman Brothers, of New York, who took it for debt. They had lately bought the Nabob, an adjacent property, and the new owners expected to begin work soon. The English company erected the Flagstaff smelter (three stacks) at the mouth of Little Cottonwood cañon, and ran it until November, 1873, when they leased the Last Chance smelter, near Sandy. Smelting was not as profitable as selling the ore, which, after April, 1876, was disposed of in the Salt Lake market. The dividends paid to the English company amounted to about $350,000. The property consists of the Flagstaff, South Star and Titus, Virginia, and Nabob. The Flagstaff is 2,200 by 100 feet, but it extends across and not along the belt. In early times, before the suits, the right to "swing their patent" was insisted on, and the workings extended 1,000 feet or more on the belt. The formation is the same mineral belt as the Emma. Ore came to the surface in one spot, and, following this indication a short distance, the discoverers came to the first and largest body. It was 400 feet long and 500 feet deep, extreme dimensions, and 3 feet wide. Some twenty or thirty other large-sized bodies were found, in all shapes and

a There has been a great amount of litigation between the English stockholders and T. W. Park and others, but these differences have recently been amicably adjusted.

positions, usually near the hanging wall, and invariably connected with one another by a small seam of ore or ocher. One body upon the foot wall was joined to another near the hanging wall by a pipe of galena the size of a lead pencil.

The total product was estimated by the superintendent to be as follows:

	Tons.
Prior to 1872	6,000
1872	8,000
1873	17,000
1874 to 1876	35,000
1877 and 1878	30,000
1879	4,000
Total	100,000

Of this, 30,000 tons probably assayed $10 gold, 60 ounces silver, and 40 per cent. lead, and sold for, or was worth, $80 per ton. The remainder probably assayed $4 gold, 30 ounces silver, and 20 per cent. lead, and was worth $30 per ton.

The mine is developed by a 530-foot tunnel, from which there is an incline 515 feet in length, at an angle of 49°. From this incline there are six levels, from 700 to 1,400 feet in length. The lower level is about 700 feet vertically below the discovery croppings. The total cuttings, exclusive of stopes, are variously estimated at from 9,000 to 14,000 feet. From the mouth of the tunnel the ore is sent to the foot of the hill on a tramway 2,800 feet in length. A 40 horse-power Babcock & Wilcox engine, situated in the tunnel, supplied with compressed air through 2,270 feet of 4-inch pipe, from two Burleigh No. 2 air-compressors, is sufficient to do the hoisting. No water has been encountered except surface water in the spring, which was controlled by a No. 4 Knowles steam-pump. The cost of the plant was about $60,000.

The South Star and Titus, an older location than the Flagstaff, has been constantly harassed by law suits. Several hundred thousand dollars' worth of ore have been extracted. It is developed by tunnel and shaft to the extent of several thousand feet. Active work ceased in 1878.

The Nabob was located in 1876. A large body of ore, lying partly in the Virginia ground, was struck in the winter of 1876–'77, which yielded about $100,000. Little has been done since. The mine is a part of the mineral belt of Emma hill. An ore body, 30 by 25 by 4 feet, was found not 50 feet from the surface. The average assay of this ore was $74 76, of which $26 was gold. The developments consist of a 115-foot incline and 300 feet of other cuttings.

The Joab Lawrence Company, the principal actively working company on Emma hill at the time of the writer's visit, was organized in the spring of 1879. Its property consists of the Vallejo and the North Star, adjacent claims, situated between the Emma and the Flagstaff. The North Star was one of the earliest claims of the district, having been located in 1865, and has yielded largely. There are said to be large bodies of low-grade oxide of iron ore in the lower levels, but little had been done for some time excepting a small amount of "tribute" work. The Vallejo was worked in 1872, 1873, 1874, 1875, and 1877 by several companies, and much ore was extracted. It was being worked on an extensive scale at the time of the writer's visit. The ore is found in irregular chutes or pipes near the hanging wall. Three bodies began near the grass roots, and others were found as depth was attained. At the period under review there were ten chutes having a triangular or lenticular cross-section, and a uniform dip SE. 80°. These were from 20 to 100 feet apart, and lay almost at right angles to the strike of the belt. The largest was 150 feet long, extreme dimensions from 6 inches to 10 feet wide, and had been followed 300 feet deep. In this mine the foot wall of the belt had not been prospected, and the horizontal development did not exceed 200 feet. It was worked by tunnels, from which were raises and short inclines. It had no machinery. The total cuttings were estimated at several thousand feet. The mine was dry. The ore was an oxide of iron, carrying galena, cerussite, anglesite, and a little oxide of manganese and malachite. It was fine, and contained from 20 to 45 per cent. lead, from 15 to 90 ounces silver, from 20 to 35 per cent. iron, and from 9 to 14 per cent. of moisture. It was in great demand among the smelters, owing to the lack of silica and the presence of so much iron. A low grade of ore containing from 40 to 50 per cent. of iron, no lead, and a few ounces of silver was also shipped. The following table shows the price received per ton for some lots of ore in February and March, 1880:

Weight.	Assay value.		Price received.
	Lead.	Silver.	
Pounds.	*Per cent.*	*Ounces.*	*Per ton.*
111,855	5	5	$10 00
76,225	41	48	66 50
58,877	42	65	85 10
54,376	35	30	52 25
74,011	12	15	17 50
130,304	43	54	73 75
140,525	6	9	12 00

The ore was transported from the mine to the tramway of the Wasatch and Jordan Valley railway by a wire-rope tramway.

The Toledo-Utah Silver Mining and Smelting Company bought the Toledo mine shortly after its discovery in 1872, and worked it quite extensively until April, 1880. The property consists of the Toledo and the Fuller claims. On the latter most of the ore has been found and most of the work done. The ore occurs in a fissure vein, from 1 to 3 feet wide, cutting diagonally across a quartzite formation, dipping N.NW. 80°, and is found in several chimneys 50 feet long on the strike, and about 50 feet apart. They dip with the strike toward the east. The ore is a hard, porous, brown siliceous oxide of iron of very high grade. It was said to have averaged from 80 to 100 ounces to the ton. Water was found 200 feet from the surface, but the character of the ore did not change. Where the vein passed from the quartzite into a belt of schist there was much pyrite. The mine is operated through a shaft 455 feet deep, vertical for part of its length. The horizontal development of the vein is 350 feet, and the total cuttings are estimated at 2,000 feet. The engine and two Knowles steam pumps are run by compressed air from a Bowers air compressor placed in the bed of Little Cottonwood ravine half a mile or more below the mine. The total product of the mine and its output during the census year were large. The exact figures cannot be given, owing to the confidential character of the information furnished.

The Emily mine is situated in a small ravine between the Toledo and Emma hill. It was discovered in 1870. It is owned by the Emily Mining Company, of Pittsburgh, Pennsylvania. They ceased regular work in 1874, and the mine has been leased since at one-fifth royalty. It is a bedded vein of clay slate in quartzite, dipping about 60° E. The ore is from 1 to 6 inches wide, and consists of quartz containing pyrite, sphalerite, galena, and tetrahedrite. When sorted it assays from $80 to $100. Mine is opened by three tunnels on the vein. The total length of cuttings is 800 feet. The mine is very wet and has no machinery. The total yield has been $15,000 or $20,000.

The City Rock and Utah group is situated at the head of Little Cottonwood cañon, and comprises the Utah, 100 by 1,000 feet; City Rock, 100 by 1,000 feet; West Wind, 100 by 495 feet; King of the West, Utah No. 2, Utah No. 3, and Freeland. The first three are on the Utah vein, and the others are on the parallel King of the West vein, 200 feet distant, and have but little development. Most of these claims were located in 1870. In 1872 much work was done. Between 1872 and 1876 the mines were involved in litigation. Twelve men were employed during the census year.

The Utah is a fissure vein, from 1 foot to 20 feet wide, dipping 70° or more NW. through strata of blue and white siliceous limestone or dolomite, which dip about 30° NE. It had outcrops in places, and is known to extend 4,000 feet in length and 700 feet in depth. The gangue of the vein is oxide of iron, and a sand, apparently the result of the decomposition of the siliceous country rock. The ore is from 1 foot to 10 feet (averaging from 2 to 3 feet) wide, immediately in contact with the walls, but not confined to either. Three chimneys have been found, 200 feet long, and about 300 feet apart. One came to the surface, and the others to within 100 feet of it. They dip with the strike about 65° NE. The positions of these chimneys appear to be determined by the strata of white limestone. The ore makes where the vein crosses the white limestone, but pinches where the harder blue limestone is encountered. It is a soft red, sometimes rather sandy oxide of iron containing carbonate of lead and galena, and in places stains of malachite. The first class assays 30 per cent. lead, 30 ounces and upward of silver, and a trace of gold. There is also much low-grade jigging ore in the mine. On the south side a dike of porphyry appears, running nearly parallel with the vein. Near the porphyry the ore has not been so rich.

The mine was being thoroughly opened at intervals of 100 feet by levels and winzes through the ore bodies Very little stoping has been done. The developments consisted of two inclines and three tunnels on the vein The lower one, which was to be the main working tunnel, is 5 by 7 feet, well timbered, has an iron rail track, and is 600 feet long. The middle tunnel, 490 feet vertically above the lower one, is 1,300 feet long. One hundred feet below this is the water level. The upper tunnel is 600 feet long, and 201 feet above the middle one. These tunnels have a grade of half an inch in 12 feet. The total cuttings amount to 4,800 feet. The cost of drifting in the vein is from $3 to $6 per foot. The cost of transportation to the tramway is $2 per ton. During the census year 385 tons of ore were sold for $25,480 67. The previous product was estimated at $50,000.

The other mines of the Little Cottonwood district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Cincinnati Group	1,500	$10,000	Worked irregularly	Ore, a sulphuret containing considerable zinc.
Enterprise	500		Idle	One ore body yielded $10,000 or more.
Dexter Consolidated	300	Small	do	
Brian Lode		A few thousand dollars	do	
Marion Group	1,800		Worked irregularly	
Manitoba	600		Idle	Vein not well defined.
Emily	800	$15,000	Worked on lease	Ore assays $80 to $100 per ton.
Caledonia	700		do	Several thousand dollars have been extracted.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Highland Chief	1,100		Idle	Ore assays 20 ounces silver and 25 per cent. lead. Many hundred tons have been shipped.
Ohio River Group	500	$60,000	Little work done	
Savage and Montezuma Group.	3,000	200,000	Idle	Ore 35 per cent. lead and 35 to 150 ounces silver.
Sticker	450	Small	do	Ore medium grade.
McKay and Revolution	1,000		Tunnel being run	A few hundred tons have been extracted.
Grizzly and Lavinia	3,000	Large	Idle	Contains large bodies of low-grade ore.
Darlington	500	Small	do	
Davenport	4,800	$600,000	do	
Island	1,000		do	Contains large bodies of low-grade ore.
Siskiyou	500	Small	do	
Alpha	500	$27,000		Average assays: 200 ounces silver, 10 per cent. lead, $10 gold.
Evergreen			Worked irregularly	
North Pole	300			Ore, galena in small seams in limestone.
Albion and Rising Sun	1,800	$100,000	Idle	
Oxford and Geneva	1,910	20,000	Worked on lease	Ore assays 30 to 90 ounces silver, 40 to 60 per cent. lead, $3 gold.
Louise	600	8,000	Idle	Ore, 10 to 12 ounces ochery carbonate and 40 to 50 ounces galena.
Sedan	300	Small		Ore, cerussite, galena, and pyrites, containing 16 to 60 ounces silver.
Frits	460	do		Vein, 20 feet; soft, low-grade ocher.
Peruvian	700	do		A few tons shipped, assaying 40 to 60 ounces silver, 40 to 70 per cent. lead, and $6 gold.
Kenosha	500	do		
Highland Boy	500	None		Small stringers of carbonate ore in limestone.

Five miles west of Alta, in Little Cottonwood cañon, there are said to be a few small veins of quartz in the granite country rock, from 1 to 3 feet wide, carrying considerable molybdenite. They assay, however, but a few ounces in silver, and have never been worked.

TUNNEL SITES.

The topography of this district is very favorable for the location of tunnel sites. Accordingly, in early times, work was begun upon a great many. They have cost fortunes, but have rarely been successful in finding ore; and though all are still claimed, few are worked more than is sufficient for assessment work. These tunnel sites, in a legal way, are a great drawback to the district. They were located before many of the present claims; they ran in all directions, and, in case large and rich bodies should be found, some of them might be used to make serious legal difficulties. The following are the principal tunnel sites in the order of their situation, beginning at the west, on the north side of Little Cottonwood, and continuing in a semi-circle around the head of the cañon:

The Frederick tunnel.—This was driven to develop the Frederick and Crown Point claims. These are parallel veins, 70 feet apart, 3 and 4½ feet wide, dipping 54° N. in limestone, and between limestone and quartzite. The ore is a carbonate, 18 inches wide, and averages 60 ounces silver and 35 per cent. lead. The claims were located in 1870, and were worked until 1873, when water and galena were encountered at a depth of 337 feet. The value of the ore sold was estimated at $35,000. The mines were leased until May, 1876, when the tunnel was begun. It is 1,300 feet long, and has to be driven several hundred feet further before cutting the veins, which are expected to be reached at 980 feet below the croppings. Its size is 6 feet 6 inches by 4 feet 4 inches. Timbering is unnecessary. The track is laid with a T-rail, 13 pounds to the yard, and has a 20-inch gauge. The tunnel is ventilated for 800 feet by a small stove and a 5½-inch pipe. A small engine is used to run a Sturtevant No. 3 fan-blower two hours twice a day. The cost of the tunnel is estimated at $17 50 per foot, which was the contract price. During the census year four or five men were regularly employed; they used single-handed drills, No. 2 giant powder, and drove the tunnel about 300 feet.

The Howland tunnel.—Work was begun on this several years ago. It has been relocated several times and was, at the period under review, known as the Solitary. Its length is 600 feet. Only assessment work is being done.

The Geneva tunnel.—Abandoned. Length unknown.

The Lady Emma tunnel.—Length, 370 feet. Relocated and called Prince of the Hills. Only assessment work is being done.

The Chicago tunnel.—Length, 600 feet. Relocated and called the Fitzgerald tunnel.

The Vallejo tunnel.—Used in the early development of the Vallejo mine.

The Utah tunnel.—Relocated as the Burgess, and used to work the Vallejo mine.

The Gladiator tunnel.—Length, about 1,000 feet. Used to work the North Star mine.

The Great Salt Lake Tunnel and Mining Company.—This is better known as the Buffalo tunnel. It was located in 1871, is 600 feet in length, and is regularly worked, 275 feet having been run the preceding year.

This company had located two claims, the Buffalo and another, having 9-inch veins, containing galena and pyrites. Three small bodies were found. The ore sold for about $80 per ton, and yielded a few thousand dollars. The Allegan mine, operated through this tunnel, has about 550 feet of cuttings, and yielded a few thousand dollars some years ago.

The Bay City tunnel.—Length, 1,700 feet. (See description of Emma mine.)

The Illinois tunnel.—Length, 800 feet. (See Cincinnati group.)

The Equitable Tunnel and Mining Company.—This company's tunnel is about 1,500 feet in length, with side drifts and winzes amounting to 900 feet, and is situated above the Bay City. Three small claims, Bolles & Collins, Equitable, and Equitable No. 2, as well as the Phœnix and the Lady Esten tunnel site, in other parts of the district, are owned by this company. Ventilation is obtained by a stove and a 6-inch pipe. This apparatus is similar to many others used in Utah. The stove is of sheet-iron, conical in shape, 3 feet high, and 3 feet in diameter at the base. It has no bottom, resting upon the earth or a bed of ashes, and is plastered around to make it air-tight. An ordinary 6-inch stove-pipe, from 20 to 25 feet high from the conical top of the stove, furnishes the draft. The door is a hole on one side, 8 inches square, covered by a closely-fitting piece of sheet-iron. A 6-inch galvanized iron pipe from the tunnel enters the stove near the base. The pipes in the tunnel are in 12-foot lengths, and are made air-tight by using tarred rags at the joints. They run near the top of the tunnel, and are supported by wooden plugs driven into drill-holes. The pipe branches off into the various drifts, and at the end the draft is nearly strong enough to draw out a candle. During the census year about 15 cords of wood were used, and seven men were regularly employed.

The Little Cottonwood tunnel.—Relocated and called the Buckland. It is 600 feet long, and was run to tap the Savage and Montezuma group.

The Reliance tunnel.—Abandoned. Little work done.

The Manhattan tunnel.—Abandoned and relocated as the McKay and Revolution. Length, 500 feet.

The Ely tunnel.—Abandoned.

The Phœnix tunnel.—Owned by the Equitable Tunnel and Mining Company. Length, 700 feet.

The Herman tunnel, known as the Tilden.—Length, 500 feet.

The Emma Hill tunnel.—Length, 900 feet.

The Victoria tunnel.—Length, 900 feet. Used to work the Victoria, Imperial, Emma May, and Alice mines. These have a large amount of cuttings, have shipped considerable ore, and are being worked upon lease.

The Christiana tunnel, known as the Oneida.—Length, 250 feet.

The Brewer & Lapham tunnel.—Length, 150 feet. Located to develop the Darlington mine.

The Lady Esten tunnel.—Length, 300 feet. Owned by the Equitable Tunnel and Mining Company.

The Iris Tunnel Company.—This was a San Francisco company which began work in the spring of 1872, and failed in the autumn of 1877, having spent about $100,000. The tunnel was taken by one of the creditors for debt. The property consists of eight locations and two tunnel sites on Emerald hill. The upper tunnel is 1,165 feet in length and has 600 feet of drifts. Two veins, from 6 inches to 2 feet and from 2 to 4 feet wide, were cut. Some galena and pyrite ore was extracted. Water is very plentiful, and the lower tunnel, 300 feet below, was run to drain the ledges. The lower tunnel is 635 feet long, and has to be run 300 feet further before cutting the first vein. The tunnels are large and straight, and are ventilated by means of a water blast driven by the waste water.

The Etna, St. Joseph, Wasatch, Silver Belt, and Rothschild tunnel sites are of varying lengths, and have all been abandoned.

Besides the tunnels above mentioned, there are many others having more or less development.

BIG COTTONWOOD DISTRICT.

[October, 1880.]

The Big Cottonwood mining district, situated in the cañon of the same name, lies north of Little Cottonwood district, and was organized July 11, 1870. It extends 16 miles east and west and 6 miles north and south, its boundaries being the summits of the ridges each side of Big Cottonwood cañon. The mines are situated, with but few exceptions, upon the southern or Little Cottonwood ridge. At the period under review records showed 1,354 locations, of which, probably, between 300 and 400 were still held. The principal camp of the district is Argenta, which has communication with Salt Lake by a tri-weekly stage. Ore is taken down the cañon to Sandy by teams. The geological formation is the same as in Little Cottonwood, Carboniferous limestone underlaid by quartzite, schist, and granite. There have been great faults, and erosion has worn precipitous ravines in the Cottonwood ridge, so that in general the surface of the country is much rougher than in the Little Cottonwood district. The mines are at about the same or, perhaps, a little higher altitude, and the deep snow and snowslides give as much or more trouble. Supplies of food and fuel are laid in during October to last until the following June.

The mines upon the north side of the cañon are the Hayes and the Maxfield. The Hayes mine, 2½ miles north of Argenta, has 400 feet of cuttings. No ore was ever shipped.

The Maxfield is situated a quarter of a mile northwest of Argenta and 14 miles east of Sandy, in a side ravine, and near the bed of the main cañon. It is owned by the Maxfield Mining Company of Salt Lake City,

incorporated in March, 1879. This company also owns the extensions or parallel claims Vinnie, Amanda, Red Pine, Tyler, and Fairview. These are mostly patented, but only slightly developed. The Maxfield is a bedded vein, from 1 to 8 feet wide, dipping 45° NE., between strata of a compact bluish-white limestone. The ore occurs usually upon the foot wall, in one chimney 200 feet long and 2 feet wide. It is a soft, brown, ochery carbonate and galena, assaying from 30 to 100 ounces. On the hanging wall there was a band of quartz, from 3 to 8 inches wide, containing galena and pyrites. When carefully sorted this yields good ore. The mine is dry and has been developed 75 feet vertically and 212 feet horizontally by a tunnel on the vein from the bed of the ravine. The total openings aggregate 800 feet. There is no machinery. During the census year about 90 tons of ore were produced, which sold for $4,518. The cost of transportation is from $4 to $4 50 per ton. The former product is roughly estimated at $20,000.

The several side ravines or forks on the south side of the main Big Cottonwood cañon, beginning at the upper end, are named as follows: Mill, South, Honeycomb, Silver, Day's, South, and Mineral.

On Scott hill, at the head of Big Cottonwood cañon, there were many prospects idle at the time, some having a large amount of workings, and showing considerable low-grade silver ore in quartzite.

MINES OF HONEYCOMB FORK.

The Butte mine, at the head of Honeycomb fork, 2½ miles northeast of Alta, was discovered in 1869, and has been worked irregularly since. It is said to be a fissure vein in limestone, from 6 inches to 4 feet wide, dipping 55° N., and is supposed to be an extension of the Utah and City Rock of Little Cottonwood district. It outcropped for several hundred feet on the hillside in the form of a soft ocher-stained limestone. Ore occurs on the foot wall in eight or ten lenticular bodies, from 1 inch to 3 feet wide, at considerable distance below the surface. It is a high-grade ocher and carbonate. Sometimes much black oxide of manganese is found. The mine is dry (excepting surface water), and is worked through a 200-foot tunnel. The total cuttings, including two old inclines, are 2,300 feet. Nine men were employed during the census year. The total product to June 1, 1880, was estimated at $27,000.

The Oregon is an extension of the Butte. The property is held by a Canadian corporation, and also includes four patented prospects on which very little work has been done; the Columbus, the Taylor, the Abbey, and the Black Bess. It is a fissure vein, from 1 to 15 feet (average, 3 feet) wide, dipping 60° N.NE. in limestone. Only one body of ore has been found. This came to the surface, and was 120 feet long, from 3 inches to 3 feet wide, and extended to a depth of 300 feet. It assayed about 50 ounces silver and 30 per cent. lead. The mine contains 1,600 feet of cuttings, and has been opened 350 feet on the dip and 480 feet horizontally by means of an 8 horse-power vertical engine. Water was found at 100 feet, but no change occurred in the oxidized character of the ore. During the census year eight men were employed, and a small amount of ore was extracted. It was idle at the time of the writer's visit, owing to the loss of the lawsuit between it and the Butte. The total product was estimated at $10,000.

The Madelon Consolidated Silver Mining and Mill Company, a New York stock company, organized in October, 1879, having 400,000 shares and a capital stock of $10,000,000, owns 5 patented and 11 unpatented overlapping claims of 1,500 by 600 feet, in all about 207 acres, at the head of Honeycomb fork and South fork. They are all prospects, few having 100 feet of development, and some showing bodies of ore of a grade sufficient to ship. It was proposed to cut these veins at a great depth by the Colbath tunnel, and perhaps to extend it several thousand feet into Little Cottonwood district, and cut the City Rock vein at a depth of about 2,000 feet. Work was begun on January 4, 1880, and from that time had been steadily prosecuted by about twelve men. The tunnel is 5 by 6 feet, and 512 feet long, exclusive of 250 feet of cross-cuts and drifts, and has a grade of half an inch in 20 feet. Good ventilation is obtained by a stove and a 6-inch pipe.

MINES OF SILVER FORK.

The Antelope and Prince of Wales group, situated on the high, steep ridge between Honeycomb and Silver Forks, 2½ miles northeast of Alta, consists of the Antelope, Prince of Wales, Wandering Boy, Highland Chief, Wellington, and Warrior claims. All were discovered about 1870. Very important lawsuits were pending between 1871 and 1875, in which the Highland Chief was defeated and a compromise was effected with the Wellington. The mines have been worked extensively since the latter date. During the census year about thirty men were employed. At the period under review there were nearly the same number, but they were, for the most part, working on contracts or leases. The ore-bearing formation is said to be a bedded vein, dipping about 45° NW. in blue and white limestone. Four distinct chimneys or chutes of ore, 130 feet, 200 feet, and 260 feet apart, have been found. They occur where the limestone is white, metamorphic, and soft; while the barren spaces between these chutes contain the vein only as a narrow seam in hard blue limestone. These chutes outcropped at the surface, or were covered by a few feet of drift, as low-grade ocher-stained seams of limestone and clay. Good ore was found by sinking a few feet. The Antelope and Prince of Wales chute is from 2 inches to 4 feet (average, 12 inches) wide, 120 feet long, and has been followed on the dip 1,200 feet. The Highland Chief chute is from 2 inches to 3 feet (average, 8 inches) wide, 75 feet long, and 800 feet deep. The Wellington chutes are each about from 2½ to 7 feet (average, 3 feet) wide, from 10 to 30 feet long, and 700 feet deep. The ore from the first assays

about 140 ounces silver and 45 per cent. lead; that from the second, 100 ounces silver and 40 per cent. lead; and that from the third and fourth, 60 ounces silver and 50 per cent. lead. The ore is a soft, brownish-yellow ocher, containing argentiferous cerussite and galena and occasional stains of oxides of manganese and copper. The mine is opened by several tunnels, the main one being 2,200 feet long, and running on the vein entirely through the ridge, and a 1,[illegible]00-foot incline, on which there are hoisting works, on the crest of the ridge. The cuttings are said to be 1,300 feet in extent. The hoisting works are large and apparently (the writer could not gain access to them) substantial, and are connected with the road in Little Cottonwood district by a covered tramway to allow the shipment of ore in winter, however deep the snow. With the exception of two or three men employed by the company, all work was done by contracts, which were let every thirty to ninety days. The miners received from $4 to $7 per foot for sinking winzes, and from $3 50 to $7 for running drifts.

The other mines of Silver fork are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.
	Feet.		
Richmond and Theresa	1,400	$150,000	Idle.
Congress	.....	.....	do.
Cooper	.....	20,000	do.

MINES OF DAY'S FORK.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Eclipse	a 158	None	Active	A two-compartment shaft was begun July 26, 1880.
Grosbeck or Emperor	1,460	....do	Idle	

a Depth of the shaft.

MINES OF SOUTH FORK.

The Reed & Benson mine is situated on a spur of the Cottonwood divide, between Day's and South forks, 11,000 feet above sea-level and 2½ miles northwest of Alta. It was located in 1870, and was worked vigorously from September, 1871, until April, 1878. Since then it has been idle or leased to a very limited extent. This mine is supposed to be upon the same mineral belt as the Flagstaff and the Emma. The belt at this point is about 200 feet wide. The ore occurs in a vein or chimney on the hanging-wall side, and in about twenty irregular lenticular bodies, which branch at all angles from the chimney, on its foot-wall side. These do not, as a rule, extend more than 75 feet from the main chimney, and vary from 6 inches to several feet in width. One outcropped as a low-grade ocher. The largest is about 170 feet from the surface. The ore is of the kind usually found in this limestone formation, namely, a yellow and red oxide of iron carrying argentiferous cerussite and galena. It is claimed that the total shipments have averaged 120 ounces silver and 35 per cent. lead per ton. The mine is developed by a 380-foot tunnel, in which there is a whim on a 400-foot incline, dipping 35° N.NE. Below this there are four windlasses, which carry the incline down 400 or 500 feet deeper. In general, the mine may be said to have been opened from the surface 1,100 feet on the dip (35°) by an irregular incline following the chimney. Near the surface the ore extended 100 feet, and the workings 200 feet, horizontally; but in the bottom of the incline not over 40 feet of drifting have been done. The openings have a total length of 1,950 feet. The mine will probably be idle until the chimney is cut by the Reed & Goodspeed tunnel. Ore is transported from the mouth of the tunnel to the foot of the hill by a 3-rail iron track tramway 1,740 feet long, having an average angle of descent of 31°. The track is 25½ inches wide. The car is 9 by 2 feet 3 inches by 10 inches. A three-quarter-inch steel-wire rope passes over a 9-foot drum controlled by a brake. This tramway was built in 1873, and cost about $20,000. Ore was then transported in wagons to the South Cottonwood smelters, 23 miles distant, at a cost of from $7 50 to $8 50 per ton. The total product is estimated at $600,000.

The Ophir is a few hundred feet southeast of the Reed & Benson, and has the same owners and officers. It was discovered in 1870, purchased by Reed & Goodspeed in 1871, leased until May, 1878, and worked steadily since by about ten men. Ore is found in three bodies in a 30-foot stratum of compact, dark-blue limestone. A stratum of white limestone above carries no ore. The outcrop was a pipe 2½ feet in diameter of low-grade ocher. The shape of the bodies is that of a flattened or an elongated ball, the largest being 50 by 20 by 15 feet. They are 4 and 10 feet apart, and not over 50 feet from the surface. At the period under review drifting was being carried on upon a seam of ocher in the expectation of finding another body. The total cuttings did not exceed 700 feet. During the census year 173 tons of ore similar to that of the Reed & Benson, excepting that it was of lower grade, assaying only about 45 per cent. lead, 42 ounces silver, with 3 per cent. moisture, were sold for $8,581. The previous product was estimated at $22,000.

The Reed & Goodspeed was located as a tunnel site to cut the Reed & Benson chimney and all blind ledges. Work was begun on it October 14, 1875, and with the exception of a few months' intermission in 1876, had been prosecuted continuously since. It is 5 by 8 feet, and 1,617 feet long, and is timbered for the first 225 feet only. It is dry, excepting surface water in the spring, and has a grade of three-quarters of an inch to the rod. The track is 25½ inches wide, and is of scantling and strap-iron. Ventilation is secured by a 4-inch pipe, a 4-foot fan-blower, and a 3½ horse-power Bookwalter engine. Work is done by day's labor, five men being employed. Blasts are made three times a day, after which the blower is run for two hours. The cost was about $20 per linear foot. It is expected to cut the chimney 400 feet farther on at a depth of from 1,500 feet to 1,800 feet from the croppings. During the preceding year the face had been advanced 330 feet. In March, 1879, the owners formed a corporation, under the name of the Reed & Goodspeed Mining Company, having a capital stock of $1,000,000 in shares of $10 each.

The Saint Louis tunnel was begun in 1875 to develop the Sampson mine, situated on the Reed & Benson ridge. Work ceased in the spring of 1880. The tunnel is 700 feet long. The Sampson mine had about 500 feet of cuttings, showing one chimney of low-grade ore. No ore had been shipped.

The Jupiter Mining Company owns several claims on the Reed & Benson ridge, 1½ miles north of the Reed & Benson mine. The developments are less than 310 feet in extent. The ore is a gold ore in narrow seams, and consists of an oxide of iron assaying from $20 to $100. No ore has been shipped.

MINES OF SILVER MOUNTAIN BETWEEN SOUTH FORK AND MINERAL FORK.

The mine of the Kessler Mining Company covers part of the ground of the old Provo claim. It was worked by a New York company in 1872, 1873, and 1874. Little ore was obtained, and it was abandoned. About 1875 a prospector discovered the carbonate ore body while overhauling the old dump, so says tradition. The mine was bought by the Carbonate Company of Salt Lake City, which extracted large quantities of ore. In January, 1879, after the large discovery ore body had been nearly all extracted, the mine was sold to the Kessler Mining Company of New York city. This company took out considerable ore and did much prospecting, but ceased work some months previous to the writer's visit, at which time the mine was worked by a few lessees. The property consists of the following overlapping, unpatented claims: Carbonate, 1,500 by 200 feet, Little Giant, Sailor Jack, Alturas, Baker, and Defiance. These are situated on the summit of the ridge of Silver mountain, about 11,000 feet above sea-level, 3 miles south of Argenta, and about 6 miles northwest of Alta. The formation is supposed by some to be a part of the Flagstaff and Emma belt. Though it is 3 miles from the Reed & Benson, its position and dip favor such a belief. The ore is found in several bodies near the surface on the hanging-wall side of a stratum or belt of limestone. The largest body was just below the surface, and was lenticular in shape, its dimensions being 200 by 100 by 50 feet. It was timbered by 365 square sets, but had caved in. The gangue, if such it may be called, which surrounds the bodies and also serves as a connecting link between them, consists of a valueless ocher or limonite. It is very abundant, sometimes fine and soft; at other points hard and siliceous. Occasionally heavy spar, oxide of manganese, and stains of malachite are found. The ore is an ocher, containing cerussite and galena, and assays from 30 to 50 per cent. lead and from 30 to 100 ounces silver. A fissure vein, called the Sailor Jack, connects with this body, and has been the cause of much litigation. There is also a vertical fault of 500 feet. The mine is opened 950 feet horizontally and 300 feet vertically, below the croppings, by six tunnels and one incline shaft. Four of the tunnels and the shaft are upon the fissure vein. The cuttings are 5,500 feet in length. The mine is dry, excepting from surface water from melting snows in the spring. There is no machinery. The ore is sent down an extremely steep and rough trail, 1 mile in length, in "stone boats" or sleds, to the bed of the South Fork ravine, whence it is conveyed in wagons 18 miles to Sandy, at a total cost of $8 50 per ton. During the census year, 692 tons were produced, which sold for $16,554 74. The total product of the mine prior to October, 1877, is estimated at $120,000. Between the above date and the beginning of the census year, 4,549 gross tons, averaging about 8 per cent. moisture, were sold for $261,044 41.

The other mines of Silver mountain, between South and Mineral forks, are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Silver Mountain Mining Company.	500	$10,000	Active	Ore assays 50 ounces silver, 35 per cent lead, and $3 gold.
Thor and Bright Point	500	2,000	do	Ore assays 60 to 100 ounces silver and 40 to 60 per cent. lead.
Elgin Mining Company	700	Small	Prospected irregularly	Veins small.
Puterbaugh	300	a $840		
Imperial Mining, Milling and Smelting Company.		Small		A few hundred feet of cuttings. Worked irregularly for two other years.
Dolly Varden	1,400	$25,000		Property in litigation.

a During the census year.

HOT SPRINGS DISTRICT.

This district is situated in the Wasatch range, adjacent to and east of Salt Lake City, extending 10 miles east and west and 5 miles north and south. It was organized in December, 1870, and now includes the old Adams and Mill Creek districts. About two hundred and thirty locations have been made, but not over forty are still held and worked. The country rock is limestone. The ore, which occurs in small veins, is a low-grade ocher containing cerussite and galena, and sometimes assays from 15 to 25 ounces silver per ton. Only a few tons have been shipped. The principal mines are the Henry, cuttings 350 feet; Lawrence, cuttings 250 feet; General Scott, cuttings 150 feet; and the Magnet iron mine, having 300 feet of openings, from which several hundred tons of flux have been shipped.

DRAPERSVILLE AND NEW EL DORADO DISTRICTS.

These districts have been abandoned for several years.

SMELTERS AND SAMPLING MILLS IN THE VICINITY OF SALT LAKE CITY.

GERMANIA SMELTING AND REFINING COMPANY.—This is the only refining works in the territory. It was completed in the autumn of 1872 as refining works only. Smelting furnaces were added in the spring of 1874, since which time the works have been running continuously in some department. It is situated on the Utah Southern railroad, 7 miles south of Salt Lake City, and consists of one reverberatory furnace for roasting ore and matte or slagging flue-dust, three shaft smelting furnaces, three softening and refining furnaces, seven pots for desilverization by zinc and refining of lead, six Faber du Faur zinc distillation furnaces, and three English cupel furnaces. This is among the most important metallurgical works of the west. It cost a large sum of money, is complete, well managed, and probably profitable. In the last few years it has divided with the Morgan and the Mingo smelters the greater part of the trade in Utah ores. For a description of the works, necessarily imperfect owing to later changes and improvements, reference may be had to the United States Mining Commissioner's report for 1873, page 261; and for 1875, page 416.

MINGO FURNACE COMPANY.—Two stacks were built in 1872, and were known as the Mountain Chief furnaces. They ran a few months, and then were idle until November, 1876, when the property came into the possession of the Mingo Company, a branch of the Pittsburgh Lead Company. The old stacks were repaired, and two others were erected in October, 1877. One or more furnaces have been run quite steadily upon ore purchased in the Salt Lake market. The works are situated a half a mile south of Sandy, on the Utah Southern railroad, are complete, clean, airy, and well managed. The apparatus consists of a Blake rock-breaker, one pair of Cornish rolls, two reverberatory furnaces for ore, matte, or flue-dust, three shaft furnaces, one No. 5 Baker blower, two Root blowers Nos. 5 and 6, two boilers, and one 35 horse-power horizontal engine.

The shaft furnaces are constructed as follows: First, 5 feet of concrete, three courses of common brick, and two courses of fire-brick arched and convex below were laid. Then the iron frame of the crucible, 7 by 8 feet, rising 28 inches above the ground line, was placed in position and the interior was filled with fire-brick, excepting a cubical 4-foot space. This was tamped with a moist mixture of two-thirds fire-clay and one-third ground fire-brick, and the crucible 36 inches deep was cut out. An opening was also made to communicate with the lead well. The shaft of the furnace rests upon a cast-iron plate supported by four hollow iron pillars 8 inches in diameter and 7 feet long, which stand at the corners and outside of the iron box. Between the crucible and the iron plate 44-inch walls of fire-brick 13 inches thick, having a batter of 12 inches, were built. The shaft of the furnace is of brick, rectangular, 5 by 5 feet 4 inches in cross-section, and 34 feet high. Size of the furnace at the tuyeres 3 by 3 feet 6 inches. Tuyeres to lead well, 10 inches. Tuyeres to charging door, 13 feet 6 inches. Each furnace has four tuyeres, two at the back and one at each side. The tuyeres are water-cooled, of wrought iron, with 2½-inch openings. They usually last two runs or about eight months. Experiments were made with two bronze and two phosphor-bronze tuyeres. These were three times as expensive, and lasted about the same time, becoming porous and leaky. It was supposed that the fire-brick walls would burn out in ten days if not protected. Small jets of water were thrown on the brick, in the smelting zone, on the back and sides of the furnace. This water ran in a channel at the bottom to waste pipes at the back and sides. Very little steam was made. Sometimes the brick crumbled under the direct action of the water. In such cases a thin sheet-iron plate was braced against the brick, and the jets of water turned upon it. In this way runs of three and four months were made. The top of each stack can be closed by a pair of doors operated by a lever. The draught is then through an inclined sheet-iron flue, which passes by each shaft furnace and into a downcast about 5 feet square, thence through an underground flue 150 feet to a brick smoke stack 93 feet high and 4 feet in cross-section. The sheet-iron flue has a cross-section of 3 by 4½ feet. After passing each stack the bottom is removed for about 8 feet, and replaced by a funnel terminating in a sheet-iron pipe 1 foot in diameter, which passes to the mixing floor. About three-quarters of the flue-dust caught is obtained here, very little being lost.

Ore is bought in the Salt Lake market (see rates under head of "sampling works"), and is then resampled at the furnace, as a check, and to give accurate data from which to calculate the percentage of loss. These lots of ore are spread in layers of uniform thickness over a rectangular area of varying size, and thus form heaps from 3 to 4 feet in height. These heaps, which are called "batches", containing from five to twenty different kinds of ore in varying quantities, are shoveled into wheelbarrows and taken to the furnace. Every lot of ore is not only assayed for gold, silver, and lead, but is also analyzed, in a well-appointed laboratory, for iron, silica, and sometimes for lime. The analyses are made rapidly, the apparatus being arranged so that one sample can be furnished in two hours or even less. Though not absolutely accurate, the results are close enough for practical purposes. For iron, 500 milligrams are boiled with hydrochloric acid, and the solution is titrated with permanganate of potash; for silica, 200 milligrams are digested in hydrochloric acid, washed with water, and from one to three times with acetate of ammonia to dissolve any sulphate of lead, dried on filter, ignited, and weighed. Slag is fused with carbonates of soda and potash and niter, and then treated as before mentioned. Ore assays are made in crucibles, one-sixth to one-third assay ton being taken. For lead assays 100 grains, and for moisture a half-pound, are taken. Two hundred lead bars, weighing about 108 pounds each, constitute a "lot". Each bar is sampled with a gouge, alternate ones upon the top and bottom, at one-fourth of the distance from the end of the bar. These samples are melted, and four assays, one from each end and side, made from the resulting bar. An average of these is taken.

The capacity of one furnace of the above dimensions is from 35 to 40 tons of smelting mixture per twenty-four hours. From eleven-twentieths to twelve-twentieths of this is ore, and the remainder flux. The iron flux comes from the Tintic district, and is hematite, containing about 50 per cent. iron, from 8 to 10 per cent. silica, and traces of gold and silver; it costs $7 50 per ton. The limestone comes from Salt Lake City, contains about 4 per cent. of silica, and costs $2 25 per ton. The fuel used is from 13 to 14 per cent. of the smelting charge of Connellsville, Pennsylvania, coke, costing from $22 to $26 per ton. The pressure of the blast is from 10 to 18 inches of water, averaging 14 inches. It requires nine hours for a charge to reach the tuyeres. Accretions of basic sulphides form on the side of the furnace about 3 inches below the feed-door. The smelting charge is so made that the slag should contain from 40 to 45 per cent. ferrous oxide, from 28 to 33 per cent. silica, and from 15 to 20 per cent. lime. The length of a run is about four months. The smelting charge contains from 13 to 22 per cent. of lead. The furnace is run with a closed hearth. The lead from the lead-well tap runs into an old slag-pot, and, when cooled somewhat, is skimmed. These skimmings, or lumps, consisting probably of subsulphide of lead, and being about one-sixth of the total product, are returned to the furnace through the feed-hole.

The various metallurgical products assay as follows:

Products.	Gold.	Silver.	Lead.
	Ounces.	*Ounces.*	*Per cent.*
Lead bullion	½	a 70 to 250	98
Matte	Trace.	15	7
Speiss	0.3	7½	7
Slag		½	½ to ¾
Flue-dust	Trace.	20	20

a Average, 100 ounces.

The flue-dust, matte, and speiss are treated in a reverberatory furnace constructed as follows: There are two hearths, one of which is level, 30 by 12 feet; the other, or slagging hearth, at one end of the first, is 10 by 10 feet, slightly concave in length and convex in width. This is to keep the material upon the slag hearth and also to make it run toward the doors. The fire-box extends entirely across the end of the slagging hearth. The walls are of fire-brick and are 13 inches thick. The height of the furnace is 10 inches on the side and 15 inches at the center. There are twelve openings, 7 by 10 inches, on a side, and closed by iron doors. Charges are fed to the furnace through two hoppers at the back end. An underground flue, 3 by 4½ feet, is connected with the main stack. The only repairs necessary are made about once a year to the fire-arch or bridge-wall. Flue-dust is wet down and put in with shovels at the back of the slag-hearth, and a very quick fire is made. It melts with very little loss and is raked out through holes at the side. Ore is rarely roasted, as sulphide ores are seldom bought. Matte and speiss are first roasted in heaps of from 50 to 200 tons. Wood to the depth of 15 inches is laid upon the ground and 4 or 5 feet of the matte piled upon it. It is roasted from four to six weeks. This imperfectly roasted material is carted to the rock-breaker and crushed to the size of a hazel nut, and is dumped through the hoppers into the reverberatories. A charge is 2,400 pounds, and remains in the furnace sixteen hours. One, however, is drawn and another added every four hours. It is stirred with a rake every thirty minutes while on the main hearth, and it is not slagged. At the best it contains several per cent. of sulphur. Six men, on twelve-hour shifts, at from $2 to $2 50, are employed on each furnace per twenty-four hours. The fuel used is bituminous coal, from 20 to 25 per cent. of the quantity of matte roasted. When one stack is running, the force of men employed is as follows:

Class.	Number employed.	Length of shift.	Wages per shift.
		Hours.	
Superintendent	1	.....	.....
Chemist	1	.....	.....
Assayer	1	.....	.....
Foremen	2	12	$5 00
Smelters	2	12	3 00
Helpers	2	12	2 25
Chargers	2	12	2 00
Supp[illegible]ers	2	12	2 25
Roustabouts	5	12	1 75
Engineers	2	12	3 00
Blacksmith	1	10	2 75
Roasting-furnace men	6	12	2 25

The lead bullion is shipped directly to the refining works of the company, located at Mansfield, seven miles from Pittsburgh, Pennsylvania.

The statistics for the census year are as follows:

Ore smelted (net)	tons..	6,950
Matte smelted	do...	1,429
Lead bullion produced	do...	2,350
Silver contained therein	ounces..	242,563.2
Gold contained therein	do...	802.72
Coal consumed (roasting)	tons..	502½
Coal consumed (steam)	do...	300½
Coke consumed	do...	2,384

Some of these amounts are approximations.

MORGAN MINING AND SMELTING COMPANY.—The works of this company are situated on the line of the Utah Southern railroad, 6 miles south of Salt Lake City. They were built in 1874, and have been running almost continually from that time. The company owns the Pittsburgh mine, in the American Fork district, but their principal ore supply is purchased in the Salt Lake market. The plant consists of a Blake rock-breaker, 9 by 15 inches; two reverberatory furnaces, 12 by 20 feet; a shaft furnace; a No. 4½ Baker blower; a hydraulic elevator to raise slag, etc., to the feed floor; a brick flue-dust chamber; and a turbine water-wheel of 40 horse-power. The furnace is a brick stack, resting upon a cast-iron plate and pillars, below which are several courses of brick and a wrought-iron water-jacket. The crucible is of fire-brick, surrounded by an iron frame. In the bottom is a firmly tamped bed of fire-clay and sand, 6 inches thick, and below all an iron plate to keep out the moisture. The furnace is rectangular and 37 by 60 inches inside measurement. The distance from the tuyeres to the lead well is 10 inches, and to the feed door 9 feet 6 inches, which was acknowledged to be too low. The sides of the furnace and jackets are vertical. The water-jacket is 7 inches thick, and is made in four sections. The side sections are stationary. The end sections are hinged at the upper corners, thus allowing them to be swung up overhead by a pulley attached to the feed floor, and giving easy access to the furnace. There are two tap holes, one at each end, and the usual lead well at one corner. The furnace is run with closed front. There are eight 2-inch tuyeres, four on each side. The tuyeres are simply holes in the jacket, fitted with small movable castings, into which the galvanized-iron air-pipes are fitted, but they are not liked. The usual tuyere-holes and tuyeres would be better, as they would now and then allow a bar in the furnace. The air-pipes are all underground, except a single T opposite the tuyeres on each side of the furnace.

The ore is bought in the Salt Lake market, and is rarely sampled again. Sometimes "batches" are made, as in the Mingo works, but not regularly; the same limestone and hematite fluxes are used. At the works the limestone costs $1 65 per ton, and the Tintic hematite from $7 25 to $8 25 per ton, depending on whether it is Dragon ore (1 ounce silver and 65 per cent. iron) or Black Stallion ore (12 ounces silver and 50 per cent. iron). Sometimes ocher from the Vallejo mine, Little Cottonwood district, containing 45 per cent. iron, 12 ounces silver, and 5 per cent. lead, is used. About 50 per cent. of flux (20 per cent. of lime and 30 per cent. of iron) is employed, so that the slag contains about 40 per cent. ferrous oxide, 30 per cent. silica, and 20 per cent. lime. The fuel is about 15 per cent. of the smelting charge, and consists of Connellsville coke, costing from $23 to $25 per ton, and charcoal at 12½ cents per bushel of 12 pounds. The proportion in which these are used varies greatly; perhaps a fair average would be 1 pound of charcoal to 5 pounds of coke. The percentage of lead in the charge varies from 17 to 20. The pressure of the blast is 1 inch of mercury. Accretions form about 4 feet above the tuyeres. The capacity of this furnace is about 20 tons of ore per twenty-four hours. The ordinary length of a run is thirty days. It requires seven hours for a charge to reach the tuyeres.

The furnace products assayed as follows:

Products.	Gold.	Silver.	Lead.
	Ounces.	*Ounces.*	
Lead	0.24	99 to 259	95 per cent.
Matte	Trace.	10 to 30	3 to 10 per cent.
Speiss	$1 50	6	3 per cent.
Slag		0.3	Trace to 1 per cent.
Flue-dust	Trace.	10 to 25	Varied with ore.

Speiss is a waste product. The flue-dust caught is estimated to be about 1⅛ per cent. of the charge. It is collected in the various compartments of a brick dust-chamber, 70 by 12 by 12 feet, having an inclined floor, from which it is scraped with hoes into vats on one side, where it is wet down and fed to the furnace daily. The smoke-stack is at one end of this chamber and 60 feet in height. The matte, mixed with refuse coke dust, is piled upon layers of wood and roasted in heaps (1 foot wood, 2½ feet matte). It is then imperfectly roasted for twelve hours in 1,200-pound charges in the reverberatories. Each furnace requires four men per twenty-four hours. The quantity of matte produced varies with the ore, but is about from one-fifth to one-eighth of the ore smelted. The slag-pots of this furnace and those of the Germania and the Mingo have about the same dimensions, and give satisfaction. The essentials of a good slag-pot are: It should be light, well-balanced, and easily moved; it should hang on the truck far enough above the ground to dump easily; it should have a large cooling surface, that the slag may chill quickly; the bottom of the pot should be of such shape that the matte will accumulate in one mass; the area of joining surfaces (matte and slag) should be small that they may be easily separated. The pots in use conform to these conditions. The dimensions are as follows: Wheels, 22 inches in diameter; bottom of pot 4 or 5 inches above the ground. A pot of slag weighs about 200 pounds, and is handled by one man.

The turbine water-wheel is 20 inches in diameter, has 22 feet pressure, and uses 1,200 inches of water, as measured by the cross-section of the flume.

The furnace force is as follows:

Class.	Number employed.	Length of shift.	Wages per shift.
		Hours.	
Foremen	2	12	$3 00
Furnace men	2	12	2 25
Helpers	2	12	2 25
Feeders	2	12	2 25
Wheelers	2	12	2 00
Weighers	2	12	2 00
Laborers	3	10	1 62
Blacksmith	1	12	2 75

The bullion produced is shipped to the Omaha Smelting and Refining Company or sold to the Germania works, 1 mile distant. The following are the statistics for the census year:

	Tons.
Ore smelted (gross)	4,797
Ore smelted (net)	4,484
Bullion produced	1,135

Containing 172,257 ounces silver and 671.3 ounces gold.

The losses of various runs during the year are reported as follows:

One run	Loss, 8.46 per cent. lead	Loss, 4.78 per cent. silver	Gain of gold.
Do	Loss, 6.65 per cent. lead	Gain, silver	Do.
Do	Loss, 5.24 per cent. lead	Gain, silver	Do.
Do	Loss, 9 per cent. lead	Loss, 10 per cent. silver	Do.
Do	Loss, 10 per cent. lead	Loss, 5 per cent. silver	Do.

Almost invariably there was a gain of one-half per cent., or less, in gold, showing traces of gold in the ore or flux, or both, which were not accounted for. The gains in silver were due to some barrings which were added to the furnace without counting their silver value. In general, in estimating loss account is taken of the difference in the assay of the lead-well at the beginning and the assay at the end of the given time, the amount of ore in the body of the furnace, its grade, etc.

The following is a report of the working of the Morgan furnace during December, 1880:

Ore smelted (gross)	tons..	595 1111/2000
Ore smelted (net)	do...	547 1468/2000
Assay value in lead	do...	205 711/2000
Assay value in silver	ounces..	2,617

	Lead.	Silver.
	Tons.	Ounces.
Bullion produced	189 1111/2000	
Silver contents		33,469.6
Contents of 62 tons of matte produced in December	7 1111/2000	1,775.0
Total	201 1111/2000	35,203.6

The loss, therefore, was as follows (including loss on working matte): Silver, 4.22 per cent.; lead, 2.06 per cent. The following table shows the material used, including waste of 3 per cent. for coke and 15 per cent. for charcoal:

	Amount used.	Cost per unit.	Total cost.	Average cost per ton.
Coke, pounds	193,600	$0 01½	$2,420 00	
Charcoal, bushels	4,760	11½	542 40	$9 25
Iron ore, tons	38.6	7 50	477 00	
Limestone, do	71	1 75	124 25	
Labor (including superintendent)			1,791 30	3 00
Sundries (oil, tools, rent, etc.)				40
Total				9 80

SATURN SMELTER.—Situated half a mile south of Sandy, near the Mingo works. It consists of three very dilapidated stacks, and has been idle for several years.

FLAGSTAFF SMELTER.—This smelter is located at Sandy, and was built about 1873 by the Last Chance Company, of West Mountain district. It was leased to the Flagstaff Company a few years later, and has been subleased occasionally by them. It has been idle since September, 1878, and is consequently somewhat dilapidated. Some of the machinery has been moved to Colorado. There are four stacks, resting on brick pillars 2 feet square. The water-jacket is in four sections, one for each side and end. The sections are from 3 to 5 inches thick and 4 feet 9 inches high. The cross-section of the furnace at the tuyeres is 4 feet by 3 feet 3 inches, and at the feed-floor 4 by 4 feet. The height of the furnace above the tuyeres is 9½ feet. The flue-dust chambers are 24 by 15 by 10 feet, and the 4-foot stack is 80 feet high. A Brückner cylinder was used to roast the matte.

STEVENS SMELTER.—This smelter is situated at Sandy, and is a new style of furnace, in which it was proposed to roast the ore with the waste heat and smelt it with gas fuel, using raw fuel, and a blast of superheated steam and hot air. This furnace is the invention of Mr. Levi Stevens. A small one was tried here several years ago, and was a complete failure. Another small one was built at Omaha in the spring of 1880, and gave such satisfaction that this large one was erected here in June, 1880. It made short experimental runs during the summer, turning out eight car-loads of bullion. The summer's work showed some defects, which were to be modified in succeeding furnaces, but in general it was satisfactory to the inventor. It is said that several have been ordered for Arizona and Colorado. The plant consists of a 24 horse-power horizontal engine and boiler, a rock-breaker, a pair of Cornish rolls, a small Sturtevant blower, and the furnace. The latter is a cast-iron box, 6 feet long, 7½ feet wide, and about 3½ feet high, having part of the bottom inclined; it is 3 feet above the ground, and rests on iron pillars. The lower part of the sides, the inclined portion of the bottom, and part of one end are protected by a water-jacket. The flat part of the bottom and the upper portion of the sides are lined with fire-brick, and the top is covered with an arch of the same material. The space left in the box (6 feet wide, 6 feet long, and from 18 inches to 2 feet high) is the crucible and the furnace proper. Joined to the inclined side is another iron box, 12 feet long, inclined at an angle of about 35°, and also resting on iron pillars. The sides are lined with fire-brick, the top is covered with an arch of the same material (the continuation of the arch previously mentioned), and the bottom is formed by a series of cast-iron shelves, 21 inches wide, 5 inches apart, overlapping 6 inches, extending entirely across the furnace (6 feet), and also partly covered with fire-brick. This is the roasting part of the furnace. At the upper end is an ordinary brick chimney, in which is a superheater—an iron box containing a coil of steam-pipe. The fire-box is at the other end of the furnace proper, and is inclosed with iron and lined and arched with fire-brick. There are two sets of grate-bars—one set inclined and stationary, and the other horizontal and attached to a rod which can be rotated from the outside of the fire-box, thus removing the clinkers. All drafts of air are excluded from the grates, except those which pass through five 3-inch holes on each side, in each of which there is a jet of superheated steam. The arched brick roof is double, having an

air-tight space of 4 inches, through which air is forced by a fan-blower into a small air-chamber over the fire-box, thence through twenty or thirty small pipes into the furnace, where it mixes with the coal gases. Of course, this arrangement gives an intense heat and melts almost anything. The fire-bridge and the arch are said to have been burned out once or twice. The iron boxing is merely the frame in which to hold the various parts of the furnace.

Ore is fed into the upper end of the roasting furnace by a conveyer. It accumulates on the shelves, and every few minutes is pushed with a small hoe from one shelf and falls to the next below, thus being roasted by the waste heat of the furnace. Two men per shift are required for this work. When the ore reaches the lower shelf it melts and runs into the crucible. The slag is tapped and the lead is dipped from an improvised lead-well as in the ordinary furnace. The roasting is imperfect, as some matte and speiss are occasionally made. Common Utah lignite coal is shoveled into a sort of hopper, from which it falls into the fire-box as fast as there is space for it and it is therefore needed. This requires about as many men as an ordinary furnace, but the cost of construction was claimed to be less. In some of the most successful runs 1 ton of coal smelted 4 tons of the smelting charge, and the loss of lead was only 8 per cent. The average loss of lead was 16 per cent. It was claimed that there was little or no loss of silver. (*a*) At times the capacity of the furnace was 25 tons per twenty-four hours. The inventor's great idea was to get heat enough, and in that he was more than successful. His trouble was in controlling the heat. Ore was sometimes melted on the upper shelf, and a white cloud of oxide and carbonate of lead was passing off in the flame that poured from the chimney. Local smelters were inclined to ridicule the new furnace. Considering, however, the inventor's lack of experience and knowledge of fluxing ores, and that this was the first real working furnace built, the results were good. It is to be hoped that additional experiments will be made with the modifications and improvements which use always suggests for new inventions.

In the proposed new furnace, the writer was told, the crucible will be 7 feet long, and a matting hearth 7 feet long will connect it with the shelves. These are to be eighteen in number, instead of six or seven as formerly, and a flue-dust chamber is to be added.

THE HORN-SILVER SMELTER.—This smelter was in process of construction at the time of the writer's visit, at South Cottonwood, on the Utah Southern Railroad, 7 miles south of Salt Lake City, and intended to smelt ore from the Horn-Silver mine at Frisco. When finished it is to contain five stacks, though at first but one is to be completed. If experiments with that are successful the others are to be built. It is to be constructed as follows: An iron plate is placed 2 feet below the surface of the ground. On this the crucible of fire-brick, having a bottom tamped with a mixture of clay, sand, and coke, is built. The water-jackets will be 5 feet high, of cast-iron, and in ten sections; four on each side and one at each end. The end sections will be hinged at the two upper corners, that they may be easily lifted up by a pulley. The cross-section of the furnace at the tuyeres (inside) is 9 feet by 40 inches, with the corners rounded on a radius of 14 inches. Cross-section at the feed-floor, 9 feet by 68 inches. Distance between tuyeres and feed floor, 10 feet 7½ inches. The ends of the furnace are vertical. Tuyeres to lead-well, 10 inches. There will be sixteen tuyeres, eight on each side, opposite each other; two tap-holes, one at each end; but only one lead-well. The capacity is estimated at 80 tons per day. Each furnace will have a No. 6 Baker blower and a separate flue-dust chamber.

THE WARM SPRINGS SMELTING WORKS.—These are situated about 2 miles north of the center of Salt Lake City. They were among the first works in the territory. Two reverberatory furnaces were erected in 1870, which were replaced by shaft furnaces. They ran quite steadily until 1877, since which time little has been done. The plant, although rather old, is in fair condition, and works small lots of ore bought in the Salt Lake market; but the establishment is not backed by much capital and is comparatively unimportant. It consists of one Gates rock-breaker; one reverberatory roasting furnace, 8 by 20 feet; one shaft furnace of 30 tons' capacity; one No. 5½ Baker blower; one flue-dust chamber, 8 by 10 by 15 feet, and one 25 horse-power engine with boiler. During the census year but two short runs were made, and less than 1,000 tons of ore were smelted. A peculiarity, which may be of value in small furnaces, is found in the construction of the upper portion of the stack. The brick terminates at the level of the feed floor. Above that point the stack is a sheet-iron pipe, 3 feet in diameter, resting on an iron tripod. The circular ring, 1 foot wide, between the brick and the iron stack, is covered with movable iron plates, thus enabling a bar to be used and a sledge to be swung to detach incrustations from the sides of the furnace.

THE NICHOLS CONCENTRATING WORKS.—These are situated on the Utah Central Railroad, in the suburbs of Salt Lake City. They were begun in 1873, when a fine three and a half story brick building, 60 by 80 feet, costing in the neighborhood of $75,000, was erected. Losses by the Chicago fire had so crippled some of those interested in the enterprise that the necessary machinery has never been added. It was intended to use Krom's dry-ore concentrating process. (*b*) While believing that the great need of Utah is concentrating works, and recognizing the value of the process upon certain ores, the writer fears that the expense of transportation of the low-grade ores from the mines to these works will prevent profitable operation.

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a Of course this is a mistake, showing incorrect assaying or sampling.

b For a description of the machinery and process, see the United States Mining Commissioner's Report for 1878, page 419.

SAMPLING WORKS.

At the close of the census year there were four sampling works in Utah: the Utah Sampling Works, at Salt Lake City; the Pioneer and the Sandy Sampling Mills, at Sandy; and McCorkindale's Sampling Works, at Milford, Beaver county. As the apparatus and processes are similar at all the sampling mills, a description of two of them will, it is thought, suffice.

THE PIONEER SAMPLING MILL.—This was established at Salt Lake City in 1871, and was moved to Sandy in 1872, where, since that time, it has been in operation continuously. The force employed consists of an engineer, bookkeeper, night watchman, and, on an average, twelve laborers. Sometimes the cars are unloaded by contract, the men receiving 10 cents per ton to handle the ore, or 12½ cents if it has to be weighed. The plant consists of a horizontal boiler 4 by 12 feet, a 15 horse-power horizontal engine, a rock-breaker 6 by 4 inches, a peculiar sampling machine, two coffee-mill crushers, a dry kiln 10 by 30 feet, several railroad and platform scales, a sampling floor in the main building 30 by 100 feet, and sheds for ore 12 feet wide by 400 feet long, 12 by 140 feet and 14 by 175 feet. The cost of the real estate and plant was about $25,000. The total amount sampled during the census year was stated to be 15,550,000 tons.

The peculiar sampling machine above mentioned was invented at this place, and cost about $4,000. It occupies a space of 8 feet square and 40 feet high. An elevator belt with buckets carries the ore to the top and drops it into a hopper, which is self-dumping when filled to a certain depth. The ore falls upon the center of two vertical partitions placed at right angles to each other, and is thus quartered. Two alternate quarters are dumped into a hopper below. This process is repeated three times. The machine was very successful with Flagstaff ore, which contained 8 per cent. moisture, but when tried on dry ores it gave too much dust, and wet ores stuck to the elevator cups. It was a great time-saver, but it gave considerable trouble to clean up. It had been idle for two years.

This mill also owned the buildings and fixtures of the old Wasatch sampling mill. They were, however, only used in case of a rush of ore.

SANDY SAMPLING MILL.—This mill was established in Salt Lake City in 1870, was moved to Sandy in January, 1876, and has been running steadily since that time. The works consist of a Brodie rock-breaker; a Coleman coffee-mill crusher; a 10 horse-power engine and boiler; sampling floor, 30 by 80 feet; dry kiln; steam room, which is used in case the ore is frozen in the sacks; and ore-sheds. The cost of the plant was about $8,000. Eight men are usually employed.

In sampling ore in Utah it is the custom to sample the entire lot if it assays 100 ounces or over, one-fifth of the lot if from 50 to 100 ounces, and one-tenth if below 50 ounces. Nothing less than one-tenth is ever taken for a sample. The uniform charges are $5 per ton for every ton sampled, the correctness of the sample being guaranteed, 50 cents per ton on the whole lot for commission, and three-fourths of a cent per sack for unsacking and reshipping sacks.

The following is the method of sampling: The ore is shoveled upon a screen with longitudinal ½-inch spaces. The coarse ore is put through a rock-breaker or coffee-mill crusher. This is spread upon the fine ore and mixed by shoveling into a heap. This heap is then wheeled away, every tenth shovelful being reserved as the sample. The one-tenth reserved is shoveled into a conical heap, every shovelful falling upon the apex of the cone. Beginning at the top of the cone, the ore is worked outward with a shovel until it covers a circle upon the floor, and is from 6 to 12 inches deep. This is quartered. Diagonally opposite quarters are rejected, and the remainder is treated in the same manner until the amount is reduced to from 30 to 50 pounds. A moisture sample of from ½ a pound to 1 pound is then taken. It is next placed on the "plate", a disk of chilled iron 3 feet 9 inches in diameter, where it is ground with a hammer like a blacksmith's flatter. The quartering process is continued until only 2 pounds remain. This is ground so that it will all pass through a No. 40 sieve, and is thoroughly dried over an oil lamp or a water-bath, and five 5-ounce bottles are filled and sealed. The label upon the bottle gives the mark of the ore, the date, the weight of the ore actually sampled, the proportion sampled, and the percentage of moisture. One bottle is kept by the sampling works, one goes to the buyer and one to the seller, and two are sent to any two of the four recognized assayers in Salt Lake City whom the seller designates. The seller then calls, gets his certificates of assay, visits the ore buyers of the Morgan, Mingo, and Germania Works, and, showing his assay certificates, asks for bids. Upon receiving them, he goes to the highest bidder, gives up his sampling mill receipt, and takes his check. All this requires but a few hours.

Ore-buyers have had no sliding scale of prices for several years, but make an arbitrary one. There was some complaint among the small sellers, who claimed that outsiders did not get within a few ounces as high assays as they deserved. From what the writer could see during a brief visit, business seemed to be conducted honestly.

All the buyers bid for ore according to the following rules: From the average of the assay certificates the total amount of gold, silver, and lead contained in the given lot is estimated. Ten per cent. of the lead and 5 per cent. of the silver are deducted for loss in smelting. The remaining ounces of silver are multiplied by the Salt Lake market price (uniformly 3 cents lower than the New York quotations). The weight of the lead is multiplied by its local market price (variable, depending on the refiners' needs). The weight of gold (if over $3 per ton) is multiplied

by $16 per ounce. These products are added, and from them from $12 to $75 per ton is deducted, depending on the character of the ore and the need of the individual furnaces of such ores. Usually only from $8 to $10 is deducted from low-grade silver ores rich in lead.

FIRE-BRICK.

Morris & Evans were the only firm in Utah which, at the period under review, was manufacturing fire-brick. The clay used was obtained from a clay vein or stratum, from 10 to 25 feet wide, on the north side of main Bingham cañon, 2½ miles below the town. They owned the clay bank, which outcropped for half a mile, and had worked it to a depth of 50 feet and about 400 feet in length. The siliceous rock used came from two quarries, one 4 miles north and the other 4 miles east of Salt Lake City. The stone from the latter quarry was an excellent fire-rock, and was used to line furnaces before the introduction of water-jackets. The works were established in 1871 or 1872, and were located about a mile and a half southwest from the center of Salt Lake City. From 10 to 15 men were regularly employed. Two kinds of pressed brick were made. The kind most used contained one-third ground fire-rock and two-thirds clay. The other kind was made of equal parts of each. These bricks were of a brownish-red color, weighed a trifle over 6 pounds, cost $65 per thousand, and were 9 by 4½ by 2½ inches in size. They have been employed in the construction or lining of all reverberatory furnaces and fire-boxes of metallurgical works in Utah, and have given satisfaction. About 205,000 were manufactured during the census year.

Several years ago a company began the manufacture of a similar fire-brick. They were bought out by Morris & Evans in the spring of 1880.

LEADING.

Leading, which is the principal cause of sickness among the miners, is caused not so much by breathing the fumes from the furnaces as from the inhalation of particles of dust in the close stopes in the dry lead-producing mines. When the symptoms appear, a rest of a week or two in the hospital generally effects a cure. In such cases large doses of chloride of magnesium are administered, also some tincture of iron. The lead is eliminated in the form of a soluble chloride. Over five hundred cases per year are treated in the two hospitals.

SUMMIT COUNTY.

UINTAH DISTRICT.

[October, 1880.]

The Uintah district is situated on the eastern slope of the Wasatch range, and covers an area 8 miles north and south by 5 miles east and west of its well rounded outlying ridges. Park City, a thriving town of about 1,000 inhabitants, about 32 miles east-southeast of Salt Lake City, and 30 miles south-southwest of Echo, on the Union Pacific railroad, is the only settlement. The district was organized July 8, 1871. The records show 1,270 locations, though not over 500 are in force. The country rock is principally quartzite, but limestone and porphyry are found. The general altitude of the mines is from 7,500 to 9,500 feet. A branch of the Union Pacific railroad, broad gauge, from Echo to Park City, was within a few months of completion at the time of visit. The Utah Eastern narrow-gauge railroad, between Park City and the Coalville coal mines, was to be completed about the same time.

The Ontario mine, the principal one in the district, as well as in the territory, is situated 1¼ miles south of Park City, in a ravine having an easy grade and smooth, but steep sides. The altitude of the mine above sea-level is 7,800 feet. It was discovered June 19, 1872, at which time it had an outcrop of ore about 2 feet square. It was sold in the following August for $30,000, since which time work had been prosecuted vigorously and continuously. The earlier workings were by tunnels on the vein from the bed of the ravine. In November, 1873, hoisting works were erected. During the years 1873 and 1874 the ore was shipped to Salt Lake City and sold. During parts of the years 1875 and 1876 the McHenry and the Marsac mills were leased and run on Ontario ore.

The Ontario Silver Mining Company was incorporated December 16, 1876, with a capital stock of $10,000,000 in 100,000 shares. A new shaft was begun in April, 1878. In the following October the old hoisting works were destroyed by a fire which started in the store-room and disabled the fire-pump and hose before it was discovered. The loss of property and supplies was estimated at $156,574. In the autumn of 1880, to avoid threatened litigation which the property had previously escaped, a compromise was made with the Last Chance and some adjacent claims, whereby 50,000 additional shares of capital stock were to be issued, of which the Last Chance was to receive a large proportion. The property of this company includes the Ontario, Switzerland, Last Chance, Banner, Great Eastern, and Monitor claims, each being 1,500 by 200 feet. The company also owns two hoisting works, one saw-mill, boarding, lodging, and store houses, two 3-acre mill-sites, and one 40-stamp mill. With the exception of a 350-foot vertical whim-shaft and about 1,000 feet of cuttings, the work of exploration had been confined to the ground of the Ontario claim.

The ore-bearing formation is a fissure vein from 4 to 25 feet (averaging 8 feet) wide, dipping about 80° E. in a seamy white quartzite. In sinking the new shaft on the hanging-wall side of the vein, the quartzite was replaced by porphyry at the depth of about 400 feet, but in cross-cutting for the vein a body of quartzite had still to be passed through. Porphyry also occurs in bunches beside the vein in the lower levels, and the indications are that as depth is attained this will replace the quartzite as the country rock. In the hill east of the shafts the ore came within 15 feet of the surface for 150 feet in length. In other other places ore which could be profitably extracted did not come within 100 feet of the surface, from which depth the ore body extended from 900 to 1,500 feet in length on the vein. Between the 100- and 400-foot levels there was a contraction of the vein for from 100 to 200 feet in length. In the lower levels there were enlargements of the vein, three chimneys, as a rule, being found upon a level. These were from 100 to 300 feet apart, from 6 to 8 feet wide, and 50 feet long. The ore is from 3 inches to 6 feet (averaging 2 feet) wide on the hanging-wall side of the vein, the richest occurring in a narrow band immediately upon the hanging wall. The ore consists of a soft bluish clay and quartz, containing zincblende, tetrahedrite, galena, pyrite, and probably other sulphides of copper, antimony, and arsenic. (a) It assays from $40 to $700, the battery samples averaging about $130 at the time of the writer's visit. That above the 400-foot level was mostly oxidised or free-milling ore, and contained horn-silver and the carbonates of copper. The gangue of the vein is quartz, mostly fragmentary, mixed with a bluish porphyritic clay containing a small percentage of pyrite. No faults have ever been found. Water was encountered 39 feet below the surface at the point of discovery. It came entirely from the foot-wall side of the vein, and had steadily increased until, at the period under review, 1,000 gallons per minute were raised.

The early working of the mine was by tunnels upon the vein, extending 400 feet either way from the bed of the ravine. A 500-foot vertical three-compartment shaft was then sunk 195 feet north of the croppings. The inside dimensions of these compartments were 4 by 4 feet, 4 by 4 feet, and 4 by 6 feet. The shaft cut the vein at about 430 feet, and is still used as a main working shaft. The new shaft, begun in April, 1878, is in the ravine, 250 feet north of the old one. It is thought that it will cut the vein at a depth of 1,500 feet. It is 700 feet in depth. Cross-cuts from the fifth, sixth, and seventh levels have been run, intersecting the vein. It has three compartments, 4½ by 5 feet, 4½ by 5 feet, and 5 by 7 feet. The timbers are 10 by 12 inches, the sets 5 feet from center to center, and lagged with 3-inch plank. The grade of the levels is three-quarters of an inch in 12 feet. The track is 18½ inches wide, and is made of scantling and strap iron. Above ground all the track is of iron T-rail. The cars are of iron, 2 feet 4 inches by 1 foot 10 inches by 3 feet 4 inches in size, and hold about 1,400 pounds. The length of the various levels is as follows: First level, 1,000 feet; second, 1,315 feet; third, 1,250 feet; fourth, 1,500 feet; fifth, 1,510 feet; and sixth, 1,535 feet. The total cuttings, aside from winzes which were obliterated as the stopes advanced, are about 12,000 feet. Most of the ore was stoped out above the 300-foot level, but in the remaining levels it was claimed that there was ore enough in sight to last two or three years at the current rate of production.

The method of working is to stope overhand, whether ore is found or not, the entire length of the chimney. The stopes are timbered with posts and caps, as the ground swells slightly. It is the general intention to keep the mine opened one level below the point where stoping was carried on. Both giant and black powder are used. Stopes are worked single-handed, and drifts and cross-cuts double-handed. Drifting costs about $7 50 per foot. Ventilation is secured through the two shafts and the numerous winzes by air currents caused by warm steam pipes; sometimes a water-blast is employed, consisting of a 4-inch pipe full of water, under 1 foot head, which falls into an 8-inch square box column 100 feet long. The air collected can be carried in 4-inch galvanised iron pipes 1,000 feet. The temperature of the various levels, several hundred feet from the steam pumps, but necessarily affected somewhat by them, is as follows: One hundred-foot level, 40½°; 200-foot level, 52°; 300-foot level, 55½°; 400-foot level, 49½°; 500-foot level, 45°; 600-foot level, 44°; 600-foot level, near the steam pump, 57°.

The hoisting works at the old shaft have been rebuilt, and occupy a building 46 by 140 feet. It contains six 54-inch by 16-foot horizontal boilers and one 65 horse-power engine. The rope is of hemp, 2 inches in diameter, and lasts about eight months. The sheaves are 32 feet in height.

The hoisting works at the new shaft are about 40 by 160 feet, and compare favorably with those on the Comstock. The machinery consists of two direct-acting, coupled, hoisting engines, with 18-inch cylinders and 60-inch stroke, of 250 horse-power, four horisontal 54-inch by 16-foot boilers, and two large Babcock & Wilcox boilers. This great steam-generating capacity is necessary to supply the large number of steam pumps employed. The pressure of steam is from 90 to 95 pounds. The sheaves are 44 feet high. A flat steel cable, 5 inches by ½ inch, cages weighing 1,100 pounds, safeties, and indicators are used. The flat cable has lasted twenty-one months, and was to be used about a year longer. At the hoisting works about 25 cords of wood and 27 tons of coal are burned daily. The pumping is done entirely by Knowles's steam pumps. A large Cornish pump has been ordered, and is to be placed in position in a few months. At the time of the writer's visit the pumps were working at their utmost capacity. A 700-gallon tank was used part of the time to control the feed. The water was pumped to the Union tunnel, 107 feet below the collar of the old shaft, through which it ran 1,851 feet to the surface.

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a From experiments made by himself Mr. Stetefeldt estimated that rich Ontario ore contained 15 per cent. zincblende, 6 per cent. galena, 3.3 per cent. fahlore, and 2 per cent. pyrite.

The following description of the pumps was furnished by the chief engineer:

Pumps.	Diameter of steam cylinder.	Diameter of expansion cylinder.	Number and size of plungers.	Estimated capacity in gallons per minute.	Strokes per minute.	Length of stroke.	Height of throw.	Location.	Remarks.
	Inches.	*Inches.*				*Ft. In.*	*Feet.*		
Knowles's compound steam	19½	30	Two 14-inch	800	35	3 00	200	700-foot level (a)	
Do	20	(f)	Two 7-inch	250	65	2 00	500	600-foot level	
Silver, Salt Lake City	16	(f)	Two 8-inch	600	100	2 00	100	do	Spare pump.
Knowles's piston	14	(f)	7-inch (b)	350	200	12	100	do	
Blake No. 8	7	(f)	4½-inch	120	(f)	10	100	(f)	
Knowles's compound double plunger	24	42	Two 15-inch	700	30	3 00	400	800-foot level (c)	To feed boilers.
Do	20	32	Two 12-inch	300	45	2 00	400	do	Spare pump.
Knowles's No. 12 fire	12	6	(f)	80	60	12	350	800-foot level	Do.
Knowles's double plunger	24	.....	Two 10-inch	600	.....	2 00	400	400-foot level	Do.
Knowles's water piston, No. C	14	d 7	.....	400	.....	12	100	300-foot level	
Knowles's water piston, No. 7	8	d 5	.....	200	.....	12	100	do	
Knowles's vertical bucket-plunger sinking	12	.....	7-inch	200	.....	12	200	725-foot level	

a North works. b Water piston. c Old works. d Piston.

In addition to these there are six Knowles pumps of smaller sizes upon the surface, for fire purposes, feed of boilers, etc.

The regular force employed at the mine is as follows:

Class.	Number employed.	Length of shift.	Wages per shift.
		Hours.	
Underground foreman	1	.....	.....
Outside boss	1	.....	.....
Chief engineer	1	.....	.....
Clerk	1	.....	.....
Carmen	11	10	$3 00
Shift bosses	2	10	5 00
Blacksmiths	3	10	3 50 to 5 00
Blacksmith's helpers	2	10	2 00
Timbermen	4	10	4 00 to 4 50
Machinist	1	10	4 50
Pipe fitter	1	10	5 00
Pumpmen	6	12	3 25 to 4 00
Engineers	3	8	4 50
Do	2	12	4 00
Chinese cooks	5	.....	1 50
Firemen	6	8	3 25 to 4 00
Carpenters	4	10	3 00 to 5 00
Roustabouts	3	10	2 50 to 3 00
Miners	70	8 and 10	3 00 to 3 50
Total	132	.....	.....

The cost of mining per ton is about $11 75.

The ore is dumped into ore-houses holding several hundred tons, which are kept constantly full. It is taken thence to the mill, about a mile down the ravine, on contract, by four-horse teams. The cost of hauling is 50 cents per ton, except in the three winter months, when it is 60 cents. At the beginning of the census year there were 42 tons in the mine ore houses. They contained 1,858 tons at the end of that year, 14,037 tons having been shipped to the mill. Thus the year's product was 15,853 tons.

The disbursements during the census year were as follows: Labor, $145,034 92; mining supplies, $110,561 72; dividends, $600,000.

The total product since the date of incorporation, and prior to the census year, was 44,776 tons, from which $2,150,000 dividends have been paid. The bullion product has been as follows:

Production prior to date of incorporation, 13,604 tons	$1,014,506 96
Production from date of incorporation (December 16, 1876) to June 1, 1879	5,039,635 97
Production during the census year	1,344,723 73
Total	7,398,866 66

[A description of the Ontario mill is given on page 276.]

The Empire Mining Company of Utah was incorporated in May, 1878. Its property comprises a group of fourteen overlapping locations 1½ miles southwest of Park City and about half a mile west of the Ontario. The average size of these is 1,500 by 200 feet. The Clara Davis alone is developed to a considerable extent. This claim was discovered in 1871; but little was done, however, until the organization of the company. Since that time it has been worked by a large force until October, 1880, when operations ceased until the Utah Eastern railroad should be completed, which would lower the price of coal and lessen the expenses $60 per day. The company also owns a 20-acre mill site, 1½ miles north of Park City, on which much grading had been done for the erection of a 30-stamp silver mill. Much of the machinery is on the ground, but financial troubles seem likely to prevent its completion. The capital stock of the company is $10,000,000 in 100,000 shares.

The Clara Davis is a fissure vein in hard quartzite, dipping about 45° S.; on the hanging wall bodies of porphyry are also found. It is in the direction of the western extension of the Ontario. The width varies from 2 to 30 feet, averaging about 6 feet. The ore, as far as known, occurs in three or four bodies, from 2 to 4 feet wide, upon the foot wall. None has been stoped, but it is supposed to average $60 to $100. The ore and gangue of this vein are very similar to the Ontario. The hoisting works consist of a substantial building, 130 by 40 feet, containing a horizontal coupled engine of 60 horse-power and four Babcock & Wilcox boilers. The sheaves are 29 feet high and the steel rope ⅞ inch in diameter and 700 feet long. The mine is very wet, 500 gallons per minute being raised during the last workings. For this purpose two Blake steam pumps, No. 3 and No. 6½, one Worthington pump, and one Crane pump are used. The shaft, which was sunk vertically from the croppings through the foot wall, is 412 feet deep and has three compartments, 4 by 4 feet, 4 by 4 feet, and 4 by 5 feet. From this cross-cuts are run to the vein at intervals of 100 feet, and drifts are then started upon it. The greatest horizontal extent of these drifts from east to west is 500 feet. The 400-foot level had not at the period under review cut the vein, owing to the inability of the pumps to control the water. The total cuttings are 2,200 feet. Ventilation is produced by a water-blast. An inch pipe throws a jet of water into a 4-inch square box, which extends 300 feet down the shaft. The imprisoned air is collected in a barrel and conveyed in 4-inch galvanized-iron pipes to the various drifts. About fifty men are regularly employed during the census year. The cost of running drifts per foot is $5; cross-cuts, $12; sinking shaft, 4 by 14 feet, $15 for labor and $4 25 for timber per foot. The cost of the improvements was $46,000.

The White Pine mine is situated on the summit and northern slope of a ridge 3 miles southwest of Park City, and has an altitude of about 9,500 feet. It was discovered in 1870. Little was done, however, until 1878. Hoisting works were erected in the autumn of 1879, and work had been prosecuted, for development only, up to time of the writer's visit. Parts of the General Washington, War Eagle, Tiney, and Addie, overlapping adjacent claims, are included in the property. The mine is known as the White Pine, although the veins carrying ore are the General Washington and War Eagle. These have a parallel strike, but different dip, being 225 feet apart at the surface, and estimated to be 400 feet apart where cut by the 400-foot level.

The General Washington vein is not worked because of legal troubles. It is a 4-foot vein in quartzite and porphyry, dipping 70° N.NE. The developments consist of a 208-foot incline and 30 feet of drifting. Water was found 80 feet below the surface.

The War Eagle vein is claimed to be a large fissure or bedded vein, about 60 feet wide, dipping 40° NW. in a quartzite and porphyry formation. The ore is principally in a band from 1 inch to 3 feet wide, and assays about $50 silver and 35 per cent. lead. Outside of this, sometimes extending for 30 feet, there is low-grade ore assaying from $5 to $30. The ore and the gangue of the vein are very similar to those of the Ontario, from which it is supposed that this was a part of the latter's vein. It may be so, but the more natural conclusion is that this is due to a similarity of the country rock. Water was encountered 60 feet below the surface, where the ore changed to a sulphuret; the quantity raised is about 900 gallons per hour. The mine is developed by a 400-foot vertical two-compartment shaft, from which cross-cuts run to the vein at intervals of 100 feet. Three levels of about 400 feet each have been driven. The total cuttings are 2,650 feet. The work has been directed to developing the property and no ore is being stoped. About thirty men were employed during two-thirds of the census year. The hoisting works consist of an 18 horse-power horizontal engine, three vertical boilers, two Knowles No. 6½ steam pumps, and ⅞-inch wire rope. They are capable of sinking the shaft 500 feet, and are reported to have cost $4[illegible]00.

The Marsac Silver Mining and Milling Company built a mill at Park City in the summer of 1874. The company also owns the Flagstaff and six adjacent claims. A two-compartment vertical shaft was sunk 400 feet with a whim. About 500 feet of other cuttings were made prior to 1878, when work ceased. A limited amount of ore was shipped. The mill is a 20-stamp pan mill, and was leased about a year in 1875–76 to the Ontario. It was repaired in 1878, and ran during the whole of 1879 on Ontario tailings. At the time of the writer's visit it was being completely remodeled. Dry kilns and a White & Howell roaster were being added. It was to be a custom mill.

In a building near the Marsac mill and owned by the company are four McKim concentrating machines, which were used successfully to concentrate both the tailings of the Ontario and the second tailings of the same mine after they had passed through the Marsac mill. The McKim concentrator, patented February 15, 1876, was invented at this place. After considerable experimenting, the machines were built in 1878 and ran nearly two

years, or until the old reservoirs of tailings were exhausted. The machine consists of a frame of 3- by 4-inch timber, 15 feet long, 5 feet wide, and 3 feet high. In this frame is an endless canvas belt 3 feet 9 inches wide, and 14 feet long (from center to center of the rollers), which passes over rollers at each end 10 inches in diameter. The canvas is nailed to laths which are on the underside or inside of the belt, half an inch apart, at right angles to its length. This gives stiffness and also a certain flexibility to the belt. Sagging is prevented by two supports on which the laths slide. The belt is level longitudinally, but has an inclination of an inch to a foot latitudinally. This can be varied to suit the ore by means of two screws to which the ends of the rollers are attached. Motion is imparted by a belt from a cone-pulley to one of the rollers. A pipe or box, pierced with small holes, runs the entire length of the upper side, furnishing a supply of water. There are also distributing boxes at one end of the upper side, troughs for the water and waste along the lower side, and boxes for the ore, which is washed from the belt at the end by jets of water. The process is as follows: The tailings to be treated are fed into a common agitator, from which they run in a stream upon the belt from the upper side at one end. The belt usually moves at the rate of 50 feet per minute. Small streams of clear water flow over it from the distributing box or pipe above. The heavier particles settle near the top, and the light ones are washed off into the waste trough. Jets of water play upon the belt as it passes over one of the rollers and wash off the adhering sands. The sands of the upper 8 inches are caught in one box as "final concentrations". Those of the next 14 inches are caught in another box as "middlings", while the lower 23 inches is waste. Two machines are placed side by side and the "middlings" are run into a third placed below. A fourth machine is used below all for refuse, etc. The "final concentrations" from all three machines are run into a settling tank and saved. Another method is to pass the "middlings" and "final concentrations" from the first two machines over the third, and the "middlings" of the third over the fourth. Two men per shift are employed, one on the agitator, and one on the machines. Sometimes a boss is also needed. The average of the tailings treated was $13. The waste sands assayed from $5 to $6. Concentrations assayed from $85 to $140. It required 17 tons of tailings to make one of concentrations. This was about the average of a shift's work. Power is furnished by a Leffel turbine wheel, 15½ inches in diameter. The penstock is of wrought-iron pipe, 1 foot in diameter and 40 feet high. The power actually required to run one machine is estimated at one-half horse-power.

The Park City Smelting Company has a small water-jacket shaft furnace in Park City. It was built in the spring of 1880, and made a short run in June. It started again in the following October, but there was not sufficient ore to keep it running longer than a few weeks. The water-jacket is of wrought iron, made in one section. It is 3 feet 2 inches high, 4 inches thick, and has a batter of 4 inches upon each side. There are five 3-inch openings, which serve as tuyeres. Ore is bought at the market prices ruling in Salt Lake City. The cost of the grading, the roomy ore-bins, and furnace building, and the particularly neat little furnace, was about $25,000.

The other mines of the Uintah district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Boss	1,200	None	30 men employed	Mining began November, 1879.
Woodside	2,736	Small	Active	Ore assays $30 per ton silver.
Walker & Buckeye	1,000	do	Idle	Ore assays 18 to 25 ounces silver and 35 per cent. lead.
Sampson Mining Company	335	None	do	
Park City Mining Company				Developments of limited extent.
Fairview Mining Company	300		Idle	
Little Mac	300		do	
Jeannette group	1,300	None	Active	Group includes twelve mines.

WASATCH COUNTY.

SNAKE CREEK DISTRICT.

[October, 1880.]

The Snake Creek district is about 4 miles wide and 6 miles long. It is south of the Uintah district and is adjacent to it. It also follows the boundary line between Wasatch, Salt Lake, and Summit counties, and includes most of the old White Pine and Howland districts. It was organized in 1870 and 1871. At the period under review there were 350 locations on the records, on 100 of which assessment work was done. The topographical and geological features of this district are similar to those of the Uintah.

MINES OF SNAKE CREEK DISTRICT.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Utah	700	None	Active	Hoisting works being built.
Jones Bonanza	1,125	Small	do	Ore assays about 75 ounces silver.
Pioneer	1,070	None	Assessment work	Ore on dump assayed 35 to 40 ounces silver.
New Bedford Mining Company.	400	do	Active	Six feet of milling ore assaying $60.

MARBLE DISTRICT.

In this district, 7 miles south of Park City, and 12 miles east of Alta, near the divide between Snake Creek and Little Cottonwood districts, the claim of the Wasatch Marble Company is located. So far as opened, the quarry is only 30 feet wide and 40 feet long; but there is said to be a vast supply of a good bluish-white marble, which it was hoped would be sufficient for the Utah trade. The company has appropriated a small water-power, and erected a mill costing about $4,000 to saw out marble slabs. Blocks from 5 to 7 feet thick and 40 feet long can be obtained. This company also owns some copper claims upon the divide. The development is nominal, but the croppings show a vein, from 4 to 6 feet wide, in limestone assaying from 10 to 12 per cent. copper, $8 silver, and $4 gold. Wood and water are very abundant. Near this copper group are many lead and silver prospects in limestone. In one, the Shenandoah, a stratum of peculiar rock, locally called "hell-fire rock", is found. It is a soft, somewhat granular, limestone which possesses the property of showing a streak of fire and emitting sparks when rubbed in the dark by any hard substance.

BLUE LEDGE DISTRICT.

[October, 1880.]

The Blue Ledge district is situated east of the Uintah and Snake Creek districts. It is very irregular in shape, but may be called 4 by 6 miles in size. It was organized April 13, 1870. There were, at the time of the writer's visit, 694 locations on record, of which probably not over 300 are still held. In this district little ore was being extracted; but works were in course of erection to thoroughly prospect some of the more promising veins.

The McHenry mine was one of the first claims located in the district. The old McHenry Mining Company was organized in 1873, and built a 20-stamp mill at Park City. The mill ran on company's ore for two months, but the ore was not free milling. The mill was then leased to the Ontario company for about a year. In 1876 the entire property was sold to the Winnamuck company, which expended considerable money in prospecting. The mine was bonded to Chambers, Hanauer & McIntosh for $140,000, who, in 1878–79, spent $20,000 in prospecting it. About December 1, 1880, the Winnamuck company again took possession. The vein is supposed to be the same as the Ontario, less than half a mile distant, owing to its location and similar characteristics. It is in quartzite, is from 4 to 10 feet wide, dips N., and has from 1 inch to 4 feet of $60 ore on the hanging wall. The mine is developed by several tunnels, which, with the various drifts and cross-cuts, aggregate 3,900 feet. The lower tunnel runs on or near the vein, is 1,300 feet long, and opens the vein 330 feet below the croppings. Much water is found.

The other mines of Blue Ledge district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Lady of the Lake	595	None	Shaft being sunk	Hoisting works contain 60 horse-power engine and 2 large steam pumps
Free Silver Mining Company.	700			Vein, 3½ feet. Development has shown little ore.
Hawkeye Mining Company.	455		Active	Hoisting works begun in July, 1880, to cost $20,000.
Williamson & Lowell			Hoisting works being erected.	Has several hundred feet of drifts and tunnels.
Homestake Mining Company.				Claims developed to a limited extent.
Little Giant Mining Company.				Do.
East Park Mining Company.				Do.
Wasatch	450	Small	Active	Ore assays from $25 to $75 per ton.
Glencoe	400			Ore assays 35 per cent. lead, 30 ounces silver, and $4 gold.
Postello	200	None		

ELK HORN DISTRICT.

[October, 1880.]

The Elk Horn district is east of the Blue Ledge district. It was organized in the spring of 1879, and had when visited 40 locations in force, with limited developments.

UTAH COUNTY.

AMERICAN FORK DISTRICT.

[September, 1880.]

The American Fork district is at the head of American Fork cañon, and is separated from Little Cottonwood district by a sharp divide. Its area is 6 square miles. The records show that 780 locations have been made from the date of its organization, July 21, 1870, to September, 1880, at which time not over 200 were actually held. Forest City, 18 miles from American Fork city, on the Utah Southern railroad, is the mining town of the district. The surface of the country is very precipitous, consisting of sharp ridges, with almost perpendicular bluffs and deep mountain gorges, the results of great faults and subsequent erosion. The formation is limestone and quartzite. The mines are mostly at an altitude of from 9,000 to 11,000 feet above sea-level. In late years, since the decline of the Miller mine, the district has been comparatively idle. During the census year about fifty men were employed either for wages or in prospecting, but at the period under review there were not over fifteen.

The Miller mine, formerly the principal mine of the district, was discovered in September, 1870, and was sold the following year for $120,000 or over. The Sultana smelter (3 stacks) was erected in 1871–'72, and ran irregularly until the spring of 1875. In 1871–'72 a narrow-gauge railroad was built up the cañon to within 4 miles of the smelter, costing $240,000, if report is correct. At the same time 25 stone charcoal kilns, 15 at the smelter and 10 at the end of the railroad, were constructed. Everything was done on a grand scale. At times 200 men were employed. The ore bodies gave out, and the company shut down the mine in December, 1876, since which time it has only been worked on lease. The coal kilns, which were of the bee-hive pattern, and held about 25 cords each, ran almost continuously from 1872 to 1877, making coal for the Salt Lake smelters. The track was taken up in 1878, and the iron sold. The bottoms of the old furnaces were torn up to get the large amount of lead contained in them, and the old slag dumps were profitably picked over four times to find scraps of lead, unreduced ore, and matte. In the winter of 1871–'72 a siphon tap, or, more properly speaking, lead-well, was invented at this smelter by Mr. J. S. Gorham, almost contemporaneously with those constructed at Eureka, Nevada, by Mr. Arents. The mining property consists of nine patented and overlapping locations adjacent to the Miller, on the summit and western slope of a very high and precipitous ridge 2½ miles north of Forest City. The fact that a large part of the old workings are filled up renders it difficult to give a full description of this mine. There are 10 tunnels, 4 shafts, and 10,000 feet of openings, exclusive of the stopes. The deepest workings are 600 feet below the hill-top, and extend horizontally 900 feet. Ore was found in six or eight large bodies, which began within 70 feet of the surface, in a belt of dolomite. About 4,800 tons were extracted from the largest body. The ore was a soft and very ferruginous ocher, containing carbonate of lead and some galena. Wulfenite and carbonates of copper were also occasionally found, together with a little zincblende and pyrite below the water-level (500 feet). Various estimates are given of the total product and the average grade of the ore. The range of these is between 13,000 and 15,000 tons, assaying from 40 to 54 per cent. lead, from 30 to 47 ounces silver, and from $2 to $10 gold. A nearly vertical porphyry dike cuts through this hill near the ore bodies, and, according to some accounts, faults the vein. The vein proper, as known at the period under review, was from 3 to 4 inches wide, containing 60-ounce ore. It was not this, however, that was being worked by the lessees. In the old ore bodies, among the crushed timbers, there were supposed to be several thousand tons of a mixture of waste and ore. Although rather dangerous work, this was being extracted and the spaces retimbered. In the early days $20 ore would hardly pay; now $5 ore will give a handsome profit. This material, together with selected portions of the old dumps, is taken a quarter of a mile, straight down a hill having a slope of 40°, in stone boats 8 feet long and 2½ feet wide, each holding about a ton and drawn by one mule, to a water-course in a ravine. In the ravine it is treated by two slightly modified Cornish hand jigs which together require about a miner's inch of water. These jigs have one man each to operate them, and make about 3 tons of concentrations per day from 15 tons of the ore. This method of treatment was possible by reason of the silver being contained in the fine crystals of cerussite, which abound in the low-grade ores. The concentrations assay about from 40 to 60 ounces silver and 60 per cent. lead. They are shipped to Sandy at a cost of $7 per ton.

The Wild Dutchman mine is a quarter of a mile east of Forest City. It was discovered in 1872, and sold to the Omaha Smelting and Refining Company of Nebraska, who worked it until September, 1876, when it was leased. It had been idle since 1880. The ore-bearing formation is a bedded vein, from 3 to 40 feet (average, 20 feet) wide, in dolomite, dipping 40° SE. This has been worked 300 feet in length and 450 feet in depth. The gangue in general consists of from 2 to 3 feet of shale upon the foot wall and a soft clay containing fragments of silica, and strongly

stained by oxide of iron, locally known as "lime porphyry." The ore occurs in scattered egg-shaped bunches of from a few pounds to 600 tons. Five large bodies have been found, one 20 feet from the surface, one 300 feet from the surface, and the others between these. The ore is the usual ochery carbonate of lead found in a lime formation, and contains small amounts of heavy spar. At the water-line, in the 450-foot tunnel level, a large body of base ore was found. This consisted of iron and copper pyrites, galena, and a very large percentage of zincblende. A porphyry dike is said to cut through the foot wall into the vein near the large bodies of ore. The mine is opened by seven working tunnels from the hillsides at various levels. The total cuttings are 3,500 feet. The lessees obtained 2,880 tons by work similar to that which was being carried on at the Miller. The total product of the mine is estimated at 7,000 tons, averaging 45 ounces silver and 40 per cent. lead.

The other mines of American Fork district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Pittsburgh	1,185	2,000 tons	Active	Ore assays 13 ounces silver, 44 per cent lead, and $2 gold.
Sunday	300	$17,000	Five men tunneling	
Silver Bell	a 120	120 tons of 150-ounce ore.	Active	
Excelsior Silver Mining Company.			do	Developments limited; ore argentiferous galena, assaying 60 ounces silver and 50 per cent. lead and a trace of gold.
Utah Consolidated Mining Company.				Seven claims. Several hundred feet of developments.
Queen of the West	1,000		Idle	In 1874 $20,000 taken from one pocket.
Orphan		250 tons	Active	Ore assays 60 ounces silver and 40 per cent. lead.
Live Yankee and Mary Ellen.		600 tons	Idle	Ore formerly assayed 18 ounces silver, 7 per cent. lead, and $4 gold.
Treasurer	475	A few tons		Ore assayed 85 ounces silver and some lead.
Silver Dipper	200			Ore assays 10 to 30 ounces silver and 40 per cent. lead.
Whirlwind	1,000	$2,000		
Non-compromise	400	15,000		Ore assayed 40 ounces silver.
Hudson		None	Some prospecting done	An extension of the Pittsburgh.

a Incline; also some tunneling work.

There are many other claims in the American Fork district, perhaps more valuable than some of those mentioned, but whose development is very limited.

SILVER LAKE DISTRICT.

[September, 1880.]

The Silver Lake district is southeast of the American Fork district, and covers an area about 6 miles square. The country is very rough and precipitous, the formation being quartzite and limestone, with some granite. It was organized in January, 1871, and the records showed 200 locations at the time of the writer's visit, of which not over 10 were held.

The mines of Silver Lake district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Milkmaid	825	$12,000	Active	Ore assays 36 per cent. lead, 24 ounces silver, and a trace of gold; sells for $55.
Wasatch King	270	300	Worked on lease	Ore assays 11 ounces silver and 27 per cent. lead.
Austin	700	None	Idle	From 200 to 300 tons ore and waste on the dump.
Nebraska	250	10 tons		Ore assays 30 ounces silver and 25 per cent. lead.

PROVO MINING DISTRICT.

[September, 1880.]

The Provo mining district lies upon the western face of the Wasatch range, northeast of the town of Provo. It was organized in the spring of 1871, but for years no regular organization has been kept up. The country rock is limestone and quartzite. The ore is an ochery carbonate of high grade in silver, but occurs in very small quantities. There were, at the period under review, about thirty claims, few of which had over 100 feet of development.

COOK AND SPANISH FORK DISTRICTS.

[September, 1880.]

These are on the western flank of the Wasatch range, south of Provo district. They were organized during the great mining excitement of 1871 and 1872. The country rock is limestone. The ore is galena, carrying from 5 to 15 ounces silver. All the mines have been abandoned.

SANTAQUIN DISTRICT.

[September, 1880.]

The Santaquin mining district was organized in 1871. It is situated east of the town of Santaquin, and occupies an area about 6 miles square.

PAYSON MINING DISTRICT.

[September, 1880.]

The Payson district was organized in 1871–'72. It is situated on the western foot-hills of the Wasatch, and is 12 miles square, having the town of Payson as a center. Seventy locations had been made up to September, 1880, at which time but five were in force. These had from 120 to 300 feet of cuttings. The country rock is limestone. The ore is low grade, from 12 to 15 ounces silver. None was ever shipped.

WHITE RIVER DISTRICT.

[September, 1880.]

The White River mining district, a mineral wax region, was organized in September, 1879. It is situated northeast of Clear Creek station, on the Utah and Pleasant Valley railroad. Its size is about 20 by 30 miles. It occupies the summit and part of the eastern slope of the Wasatch range, and lies in both Utah and Wasatch counties. There are about forty locations, the average dimensions of which are 1,500 by 600 feet. The developments in no place exceed 50 feet of shaft. A shale, which is said to extend many miles, lies in nearly horizontal beds of varying thickness. The reports conflict, but there are evidently two or three beds from 60 to 600 feet thick. This shale has yielded from 13 to 45 per cent. of paraffine oil and some wax. The wax proper (ozocerite) is found in sandstone at the base of the ridges and under the shale. It occurs in small isolated bodies and in seams. The seams are generally from ½ inch to 3 inches wide, and rarely 8 inches. The total product has been about 1,500 pounds. This crude material was said to average 25 per cent. paraffine wax. Cleaner pieces, having less admixture of sandstone, yielded from 90 to 95 per cent. by analysis.

The Tintic Mining and Milling Company's mill is situated at Homansville, Utah county, just over the line from Tintic district, Juab county, from which it obtains its ore. It is 2½ miles east of the Eureka Hill mines and 18 miles west of Santaquin. The mill was built by an Ohio company, called the Wyoming Mining and Milling Company, and started in January, 1873, on ore from the old Wyoming mine. This mine failed, and the company bought others and milled much ore during the year. In the spring of 1874 Colonel Locke took charge, and purchased it in February, 1877. The mill was bought by the Tintic company, and began operations July 14, 1880. The mill is very neat, fully equipped, substantial, and convenient. It was built at a cost of $65,000. It contains a Blake rock-breaker 8 by 10 inches, a dry-floor 10 by 30 feet, ten 750-pound stamps, four Horn pans 2 feet 2 inches by 4 feet 8 inches, two settlers, 3 by 8 feet, a clean-up pan, a retort, a Stetefeldt furnace, and a very fine 45 horse-power engine made in Marysville, California. The batteries are double-discharge, and have a No. 40 brass wire screen, 8-inch drop, speed 90, and a capacity of from 7 to 20 tons per day, depending on the ore. The pans hold 1,800 pounds, and are run eight hours. No chemicals, except a little potassium cyanide, are added. The loss of mercury is 1 pound per ton. Settlers containing two-pan charges are run eight hours. The bullion is from 0.300 to 0.650 fine. There are about 4,000 tons of tailings in the reservoir. These assay $9 per ton. The Stetefeldt furnace has a 40-foot shaft with pit 5 feet square, flue-dust chambers 42 by 15 feet by 12 feet, and 100 feet of underground flue to a 70-foot stack. It requires the labor of four men and 1½ cords of wood per twenty-four hours. From 5 to 6 per cent. of salt is used. The company's charges are $25 per ton for working, guaranteeing 80 per cent. in bullion of the assay value of the silver, and also of the gold if it exceeded $10 per ton. The product of this mill while under Colonel Locke's management, from the spring of 1874 to the spring of 1878, was $39,058 73 gold and $241,112 23 silver, from 3,261.7 tons of ore.

The Pleasant Grove clay bank was discovered in early days. From six to ten car-loads per year have been shipped to the Salt Lake smelters. The price obtained was $3 50 per ton. This bed of fire-clay is situated 1 mile northeast of Pleasant Grove at the base of the Wasatch mountains. It is exposed only for about 100 feet in length and 50 feet in depth, but surface signs seem to indicate a bed at least 200 feet in thickness. It is overlaid by a lime shale, dipping slightly to the east. Several inches of water flow from the mountains at the line of junction between the clay and the shale.

TOOELE COUNTY.

RUSH VALLEY DISTRICT.

[November, 1880.]

The Rush Valley mining district is situated among the foot-hills, on the western slope of the Oquirrh range, and covers an area about 7 miles square. Its altitude is between 6,000 and 7,000 feet. Stockton, the town of the district, is 38 miles southwest of Salt Lake City, and a mile from the terminus of the Utah Western railroad. The district was organised by soldiers in June, 1865. In May, 1870, there were 850 locations on the books, but most of the titles had lapsed. At that time a party of miners came from White Pine, reorganised the district, and jumped everything. Very little was done in the district until 1875, when there was quite an excitement. It gradually died out, however, until 1879, when the large ore body in the Great Basin mine was discovered. Except at the above mine little is being done. The records since 1870 show 340 claims, not more than 125 of which were ever worked. The country rock is a siliceous limestone and quartzite, the strata having a general east and west strike, and belonging to the Carboniferous age.(a) The veins are for the most part large, but contain a large amount of valueless or low-grade ocher. It is a peculiarity of the region that the silver is not found as a chloride, but is associated with cerussite and galena, thus making it a good "jigging" ore. There are two classes of veins in the district, E. and W. bedded veins between a black and gray siliceous limestone, of which kind there are three belts, and fissure veins having a N. and S. strike. These last, with the exception of the Catherine, have never yielded much. There are also several granitic porphyry dikes having a general NE. and SW. strike.

The Great Basin mine is the principal mine of the district, and is situated 1¼ miles northeast of Stockton. It was discovered in 1865, and, except a small interest, was owned by General Connor. It was worked at intervals on lease until 1879, when a large body of ore was found at a depth of 250 feet. General Connor then went east, and, securing Boston capital, the Great Basin Mining and Smelting Company was incorporated in May, 1879, under the laws of Connecticut. This company has erected concentration works and is working vigorously. The property of the company consists of the Great Basin, the General Garfield, and the Arthur, parallel side claims, and the Silver Queen, a vein at right angles; the concentration works; a smelter, formerly the Jacobs smelter; and some large springs connected with the town and works by 6 miles of 4-inch pipe. The capital stock of the company is $2,500,000 in 100,000 shares. The ore is found in irregular masses in a bedded vein, from 9 to 16 feet wide, dipping from 60° to 70° N.NE., between a black limestone hanging wall and a hard, gray siliceous limestone foot wall. The outcrop is a broad band of ocher. Ore in small quantities was found from 10 to 30 feet below the surface, but no large bodies were encountered until a depth of 250 feet was reached. The vein is supposed to extend for several thousand feet, and has been explored 460 feet horizontally and 340 feet on the dip. The ore is a soft, fine ferruginous and siliceous material containing crystals and nodules of carbonate of lead, bowlders of galena, some oxide of manganese, and rarely a stain of carbonate of copper. It is of all shades of brown, red, and yellow. The best ore is as a rule found nearest the foot wall. On the hanging wall is a band of ocher, worthless or of extremely low grade. On each side of the ore proper there is a 3- to 5-foot belt of soft decomposed country rock strongly stained with oxide of iron, with frequent seams of talcose clay. The ore averages from 3 to 5 feet in width. The size of the bodies in sight could not be determined, as comparatively little drifting had been done. The main body or its branches are continuous between 250 and 340 feet on the incline. From the above the banded structure of the vein is manifest. There is a small fault where the Silver Queen fissure cuts across this vein. At the bottom of the incline a dike of porphyry has just been encountered. Ore is in contact with it. No water has been found, but as the ore is very moist it is expected daily. The mine is opened by an 840 feet incline on the vein. This is at an angle of about 50°, making an angle of 15° with the true dip. From this 2,585 feet of levels, cross-cuts, and winzes have been driven. The hoisting works, though rather rude, serve the purpose. They consist of a 16 horse-power horizontal engine, with 1¼-inch hemp rope, and a single horizontal boiler. Ore is hoisted on a giraffe holding about 1 ton and having a sheet-iron cover to prevent ore from falling out on steep places in the incline. The machinery for new hoisting works has been ordered. The ore is extracted by overhand stoping, the ground being timbered only by stulls. The ground is soft, so that black powder is in most cases used. During the census year 45 men were employed. Shifts are 10 hours day and 9 hours night. Miners receive $3 per shift. Wood costs $8 per cord and drifting $6 per foot. First-class ore, averaging 40 per cent. lead, from 18 to 21 ounces silver, and $2 gold, is shipped to Salt Lake City at a cost of $3 25 per ton; but it is intended for the future to smelt it at the company's works. During the census year $48,275 33 was received for 3,382¾ tons of ore sold. The former product was estimated at $20,000.

The concentration works are located at Stockton, 1¼ miles from the mine, on an easy descending grade. The buildings are those of the old Jacobs smelter erected in 1872. They were bought by the company in 1879, and enlarged for the concentration plant. Owing to the fact that they were not originally designed for concentration works they are not models of elegance or convenience, but they do good work. The concentrating apparatus was completed in June, 1880, and with some slight stoppages has been running since that time. As they are the only

a E. E. Howell. Explorations west of the 100th meridian. Vol. III, p. 237.

works of the kind in Utah, those at the Old Telegraph being out of repair, and as the subject of concentration is a very important one, they are deserving of special description. The apparatus consists of a Dodge crusher, a pair of Cornish rolls, a chain bucket-elevator, 5 revolving screens, 8 Fraser & Chalmers automatic jigs, and 4 tie-boxes. The whole is run by a horizontal engine of 50 horse-power. The building is lighted by two Brush electric lights of 2,000 candle-power. This apparatus require about 3 horse-power from the engine, and cost $950. Four Jablokoff carbon candles are burned per night at a cost of 20 cents. These gave such satisfaction that a third light was to be placed upon the dump. The Cornish rolls are each 2 feet in diameter, and are fitted with steel shells. Although they had crushed several thousand tons of ore, they showed but little wear. The chain elevator carries cups, holding about a quart, 15 inches apart. It raises ore to the top of the building, 25 feet, and makes a little more than one revolution per minute. The five revolving screens are so arranged that whatever passes through the mesh of the screen is caught by a fixed semicircular sheet-iron trough below, having sufficient grade to pass it into the end of the succeeding revolving screen. Whatever does not pass through the first screen is discharged into a box tube and falls back to the Cornish rolls 15 feet below. That which does not pass through the mesh of screen No. 2 falls through a box tube to jigs No. 1. In the same manner screen No. 3 sends material to jigs No. 2, screen No. 4 to jigs No. 3, and screen No. 5 to jigs No. 4. Whatever passes through the mesh of revolving screen No. 5 (about one-half of the total ore) goes through troughs to a small reservoir, and thence to the tie-boxes. Screen No. 1 is 10 feet long, 2 feet in diameter, and has a grade of ¾ inch to the foot. The first 3 feet is of sheet iron, and the remainder is covered with a No. 4 mesh iron-wire screen. This screen receives the ordinary dry ore. Screens Nos. 2, 3, 4, and 5 are each 5 feet long, 2 feet 9 inches in diameter, and has a grade of ½ to ¾ inch to the foot. Above each of these is a small level water trough. This is made to overflow, thus washing the screens clean and aiding in the sifting. Screen No. 2 had No. 3 and No. 4 mesh, half and half each; No. 3 has a No. 6 mesh; No. 4 has a No. 9 mesh, and No. 5 has a No. 14 mesh. Each screen makes about 100 revolutions per minute. The jigs are 9 feet long, 3 feet wide, and 3 feet high, the lower half of the box being V-shaped. They are made of 2-inch plank, arranged upon the floor in two rows 6 feet apart, and are held in position by a frame-work of 6- by 6-inch timber. To a shaft running the entire length of each row are attached the eccentrics and plungers. Each jig is divided into three compartments by two crosswise partitions. Each of these compartments is subdivided, at the top only, into three others—the screen proper, the plunger, and the water-supply portions. These are, respectively, 15, 16, and 3 inches wide. The plungers fit the compartment quite closely, but are not water-tight. The screens of the successive compartments are level, and each is 2 inches lower than the preceding one. They are covered with particles of galena, just large enough not to admit of their passing through. This is called "ragging". There are two jigs of each number. The screens of jig No. 1 are the same as those of revolving screen No. 2; of No. 2 as revolving screen No. 3; of No. 3 as revolving screen No. 4; and of No. 4 as revolving screen No. 5. There is a faucet or hole, fitted with a plug, in the bottom of each compartment of the jigs, through which the material which passes through the screens (called the "hutch-work") is drawn off into shallow vats. The tie-boxes are 13 feet long, 19 inches wide, and 8 inches high, with a grade of from 6 to 7 inches.

The process is as follows: The ore on the ore-floor, where it has been dumped by teams from the mines, is shoveled into wheelbarrows and taken into the mill. If it is already fine, it is dumped through a chute having a false bottom of ½-inch mesh wire screen to the Cornish rolls. The fine stuff which is thus screened out goes to the elevator pit. If the ore is coarse it is put through the Dodge crusher, whence it passes through a similarly constructed chute to the Cornish rolls. Whatever passes through the Cornish rolls also falls into the elevator pit. The elevator carries the ore from the pit to a chute, whence it is dropped into the revolving screens and is sized, as previously mentioned. It will be noticed that the material which falls to each jig is small enough to pass through the mesh of the jig screen, if not prevented by the "ragging". By the action of the plunger, which has a stroke of three-quarter inch in jigs No. 1, and one-eighth inch in jigs No. 4, making two hundred strokes per minute, the water is forced up through the meshes of the jig screens, somewhat displacing the ragging. This upward current of water also lifts the particles of ore. The lighter are carried to the left by the force of the flowing water, while the heavier settle back near their original positions, and finally sink through the screen into the box beneath, and become hutch-work. The very light portions are removed further and further away, until finally carried by the water over the discharge spout. It is evident that the hutch-work in the first compartment will be the richest. The jig sands over the jig screens are kept about 2 inches deep. Each jig uses about an inch pipe full of water with very little head. The hutch-work is drawn off through the faucets every hour or so, shoveled into wheelbarrows, and wheeled to the sacking-floor or furnace-room. It is not "tied". The quantity of hutch-work produced by each set of jigs was about the same. In the tie-boxes, the first 4 feet is saved and the next 5 feet, called "middlings", "retied". The lower 4 feet is rejected as waste.

Unfortunately, accurate average assays of the various products cannot be given, as they are not regularly made. The following are estimated values:

Concentrating ore from the mine	8 ounces silver, 13 per cent. lead.
"Hutch-work" or jig ore	40 ounces silver, 55 per cent. lead.
"Tie-box" ore	20 ounces silver, 40 per cent. lead.
Waste	3 ounces silver, 5 per cent. lead.

It usually requires from 5 to 6 tons of ore to make 1 of concentrations. It is estimated that about 75 per cent. of the value of the ore is saved, though this is somewhat inconsistent with the other data. The capacity of the works is about 80 tons per day. The cost of plant was $25,000. The cost of concentration per ton of ore is 75 cents.

The force employed is:

Class.	Number employed.	Length of shift.	Wages per shift.
		Hours.	
Foreman	1	12	$5 00
Tie-box men	4	12	3 00
Engineers	2	12	3 50
Ore feeders and laborers	12	12	2 00
Jig tenders	3	12	3 00
Total	22		

This large force of laborers is owing to the unfortunate topographical situation of the works. The ore does not fall by gravity to its place at the crusher or rollers, but has to be lifted by laborers and wheeled there.

The furnace department of these works was not in running order at the time of the writer's visit, but was expected to be shortly. There is but one stack, which had been remodeled somewhat since its use in the old Jacobs smelter.

The First National mine is 1⅛ miles northeast of Stockton. It was discovered in 1872, and considerable ore was extracted from near the surface. The mine has been worked irregularly since 1875, a small force being employed. It is a bedded vein, from 1 to 15 feet wide, dipping from 50° to 70° N.NW. The vein is filled with ocher, especially upon the hanging-wall side, and a partially decomposed siliceous limestone. The ore is cerussite and galena, with oxides of iron and manganese occurring in irregular masses in the vein, and assaying: first class, 40 ounces silver and 70 per cent. lead; second class, 30 ounces silver and 45 per cent. lead; third class, 18 ounces silver and 25 per cent. lead. There are also five or six pockets of galena, containing from 1 to 40 tons near the surface, in the foot wall, from 30 to 50 feet from the vein. Bodies are also found at a depth of from 250 to 370 feet. The mine is dry, and is developed by a 450-foot incline and 1,100 feet of other cuttings. It has small steam-hoisting works containing an Ames 8 horse-power engine, costing about $2,000. The total production to the end of the census year was estimated at $18,000.

The other mines of the Rush Valley district are:

Mines.	Total length of openings.	Total product.	Condition at close of census year.	Remarks.
	Feet.			
Rush Valley M. Co	420	None	Active	Steam hoisting works erected, cost $5,000.
Southport	225	Small	Assessment work	
Merwin and Maybell	410			
Granger and Jasper	330			
Leonora	1,200	$25,000	Idle	Ore assays 40 ounces silver, 55 per cent. lead, $5 gold.
Legal Tender	a 300	1,800 tons		Ore assays: first class, 18 ounces silver, 50 per cent. lead; second class, 10 ounces silver, 20 per cent. lead.
Katharina	1,100	$15,000	Small force at work	
Chaco and Vulcan	a 350			Product a few thousand dollars.
Silver King	900	3,000 tons	Idle	Selected ore assays 20 ounces silver, 40 per cent. lead.
Silver King W. Extn	850			Much low-grade ore shipped to Chicago furnace.
No-You-Don't			Idle	Several hundred feet of workings.
Wade Hampton	a 300		Worked on lease	Several thousand dollars have been received for ore.
Argent	600		Idle	Do.
Muscatine	a 625		Assessment work	Many hundred tons of low-grade ore produced.
Calumet	300	$6,000		Ore assays: first class, 70 ounces silver, 70 per cent, lead; second class, 45 ounces silver, 50 per cent. lead; third class, 12 ounces silver, 15 per cent. lead.
Hannah			Idle	Has yielded a few thousand dollars.
Gen. Connor Tunnel	400	None	Six men tunneling	
Lion	575	$30,000	Idle	Ore assays 60 ounces silver, 65 per cent. lead.

a Incline; also other cuttings.

The Waterman smelter is situated half a mile southwest of Stockton, near the northern shore of Rush lake. The first furnace in the territory, an unsuccessful reverberatory, was erected here in 1864 by General Connor and his officers. It was bought in 1871 or 1872 by Mr. I. S. Waterman. Two stone stacks were erected, and water-jackets were finally added. The buildings were burned in 1876, but were immediately rebuilt. This smelter ran quite steadily for several years on Hidden Treasure ore and some custom rock, but not profitably. It has been idle for nearly two years. The works are neat, roomy, and in good condition. All parts of the building are made of sheet iron, or lined, or covered with it. There is also a fine brick boarding-house and office. The machinery consists of a Blake rock-breaker, two No. 5 Baker blowers, two steam pumps, two horizontal boilers, 4½ by 16 feet, a 40 horse-power engine, and two shaft furnaces. These latter are water jacket furnaces of about the same size. There is a flue-dust condenser, invented by a former superintendent. It is so constructed that the dust should pass through water, the draft being increased by a fan blower. Owing to idleness of the works it cannot be described. A report made by George W. Maynard gives the following details: During the four years ending April 1, 1878, 26,270 tons of ore were smelted, and yielded 8,312 tons of base bullion, which sold for $109 64 per ton, or $911,350. During this time 3,300 tons of flue-dust were caught, which assayed from 36 to 57 per cent. lead and from 13 to 35 ounces silver.

The Chicago smelter is at Slagtown, on the eastern shore of Rush lake, about 2 miles south of Stockton. It was built in 1873 by the Chicago Silver Mining Company, an English company, which once owned the Chicago and the Queen of the Hills mines in Dry cañon. It ran quite steadily until 1877. It was then idle until leased in 1879 to Mr. Brooks, who ran it until the autumn of 1880, when it was shut down. The plant consists of one 50 horse-power engine, two boilers, two Blake rock-breakers, one No. 6 Baker blower, and three stacks with small dust chambers. (For dimensions of these see table of Utah furnaces.) These stacks are similar to the others, excepting that the water-jackets might more properly be called spray-jackets. One stack has a rectangular cross-section 4 by 3 feet. The jacket is in four sections, one on each side and end. These sections are 3 feet high, and are made of cast iron. They have no open space between the walls to contain water, but instead have three flanges upon the outside which form three V-troughs 2 inches deep. These are set level, and a stream of water is poured into the upper one. It overflows into the middle and lower troughs, from which it runs off in a pipe, thus wetting the entire side of the jacket. The cast iron is about an inch thick. The jackets appeared to have stood well without warping or bulging. One stack has a hexagonal jacket, 1 foot 9 inches on a side, having the same V-troughs. Another has a circular 5-foot jacket of cast iron, single thickness, without the V-troughs cast on the side. This is used with a spray of water.

OPHIR MINING DISTRICT.

[November, 1880.]

The Ophir district is situated south of and adjoining Rush Valley district, from which it was separated in the summer of 1870. It includes several cañons and ridges on the western slope of the Oquirrh range, the principal of which are Ophir or East cañon and Dry cañon, containing the mining camps of Ophir City and Jacob City, respectively. There was much excitement in 1872, 1873, and 1874, since which time the camp has gradually declined. At the period under review there were not 50 persons where formerly there were 1,000. The records showed about 2,500 locations, on not over 150 of which was assessment work kept up. The surface of the country is very rough, consisting of steep hillsides and precipitous walls of mountain gorges. The altitude of the claims varies from 6,500 to 9,000 feet. In general, the country rock consists of a distinctly stratified limestone, having a small northerly dip. Near Ophir City, there are strata of quartzite and siliceous limestone. In many places, particularly in Dry cañon, the limestone is interstratified with calcareous shale. In this place, also, there is one large dike of granitic porphyry and several great faults.

Much of the ore of the district has been very rich, the assays sometimes averaging among the hundreds, and even thousands. In East cañon the ore was usually a very siliceous or milling ore; but that from Dry cañon contained much lead, and was smelted. This district has produced many million dollars; how many, can never be known, as the mine owners of the early days are scattered over the Pacific coast. Many local attempts to treat the ores were made in East cañon, but were for the most part failures. The works remaining at the period under review were the buildings of the Pioneer and the Baltic mills and the Cleveland and the New Jersey arrastras.

The Pioneer mill was built in 1871 by Walker Brothers, of Salt Lake City, to work ore from the Zella group and other mines on Lion hill. It was a 20-stamp dry-crushing silver mill with an Aiken furnace, and cost about $75,000. Many hundred thousand dollars in bullion were extracted. The machinery was moved to Butte, Montana, several years ago. The Baltic mill was a small 5-stamp mill, with two pans and a settler, and was run by a turbine water-wheel. It was not worked regularly. The arrastras were in bad order, not having been in operation for several years. They were usually run by water-wheels. A small boiler furnished steam. They were fairly successful, owing to the high grade and free nature of the ore. Latterly, ore has been shipped to Salt Lake City or to the Stockton smelters. The distances and costs of transportation are as follows:

Jacob City to Stockton, 10 miles, from $2 50 to $3 per ton.
Ophir City to Stockton, 16 miles, $4 per ton.

The following works were built in early times, but had been moved away or were in ruins:

Pioneer smelter, built in 1871. Probably produced 125 tons of bullion.
Ophir smelter, built in 1872. Produced but little.
Faucett smelter, built in 1872. Small product.
Brevoort mill, built in 1872. Two stamps.
Enterprise mill, built in 1873. Five stamps.
One mill (name unknown), built in 1874. Five stamps.
Also several small arrastras run by water-wheels.

Owing to the extreme dullness of the camp when visited, it was impossible to get full information of many of the mines. Hence probably some will be omitted and others will be described very imperfectly.

MINES OF EAST CAÑON AND VICINITY.

The Zella group comprises the Zella, Mountain Tiger, Silver Chief, and Rockwell, patented, and several others unpatented. It is situated on the western side and near the summit of Lion hill. The mines were discovered in the autumn of 1870, and sold to Walker Brothers in 1871, who worked them until 1876, since which time they have been leased. The ore outcropped in two places, the croppings assaying $200 per ton. Three large bodies and several smaller ones were found about 20 feet below the surface. The ore is a soft, yellow, siliceous chloride assaying several hundred dollars per ton. The country rock is blue limestone. No water has been encountered. The mines are opened by several shafts and tunnels, in all over 6,500 feet. The actual working development on the stratum containing ore does not, however, extend over 125 feet vertically and 800 feet horizontally. During the census year the property was leased to six men at a royalty of from one-third to one-sixth of the net receipts. Eighty-four tons, assaying about 120 ounces silver and $9 gold, selling for $100 per ton, were obtained. It was impossible to ascertain, except approximately, the total product of this group, but it was estimated at $750,000.

The Monarch group includes the Monarch, Monarch No. 2, Monarch No. 3, and Empire. The mines were discovered in 1870. The principal work was done in 1875 and 1876. Since then the property has been leased. The ore is found in a stratum of quartzite, dipping slightly NE. There is limestone below, and porphyry, in some places at least, above this stratum. The explorations were in a space from 5 to 25 feet in height, and 500 by 400 feet in length and breadth. There are two or three large bodies, one 75 feet long, from 3 to 30 feet wide, and from 2 inches to 12 feet (average, 2½ feet) thick, and several smaller ones. The ore is a porous quartz containing cavities filled with the "chloride" of the miners and some carbonate of lead. In the center of the body it is quite soft and fine, but upon the edges very hard and coarse. It is said that the ore averages 130 ounces silver per ton with from nothing to $8 in gold, and from nothing to 12 per cent. of lead. Much of it, however, would assay upwards of $500. The mass of the quartzite stratum near the ore is much broken, and the seams are filled with crystals of quartz and calcite, all being somewhat stained with oxide of iron. The chlorider's rule in seeking new ore bodies is to follow soft ground and the stronger ocher stain. The richest ore occurs next the lime and the porphyry. The mine is worked through tunnels, and has about 2,000 feet of cuttings. In no place are these over 125 feet below the surface. Six men were working on lease seven months during the census year, paying from one-third to one-fifth royalty. They took out ore which sold for $12,556. The total product to the close of the census year was $117,500.

The Douglas mine was located in 1871, and was worked principally in 1875, 1876, and 1877. It has been idle or leased since. It is situated near the western summit of Lion hill, about a mile southeast of Ophir City. It is near the Monarch group, which it greatly resembles in gangue and ore. The country rock is stratified limestone. Whether the quartzite gouge of the two former claims is an interstratified quartzite bed or a local mass of quartzite cannot be determined from the developments. This stratum is 30 feet thick, and is known to extend 250 by 350 feet. Two bodies have been found of about the same size 50 feet apart. One is 150 feet long, from 2 to 12 feet thick, and from 4 to 15 feet wide. The mine is dry and is opened by tunnels and shafts. It is worked over 150 feet from the surface, and has about 600 feet of cuttings. The total product is said to be at least 1,000 tons of 100-ounce ore. This is worked at the Pioneer mill.

The Trace group was located in August, 1878, and worked in a small way since by the owners. It embraces four claims on the northern slope of Lion hill. The principal claim is located on a fissure vein, from 6 inches to 6 feet wide, traceable for 900 feet through blue limestone, dipping 75° W. The ore is found mostly on the foot wall from 2 inches to 2 feet wide, but there is also a band of it upon the hanging wall, which contains much more gold ($20) than the other ore. Between these bands of ore is an open fissure, from 5 inches to 2 feet, sometimes filled with a lime sand from the surface. The ore is a soft yellow sandy ocher, which assays: first class, 130 ounces silver and $9 gold; second class, 71 ounces silver and $12 gold. The mines of this group are developed to a limited extent, mostly by tunnels, and contain over 1,000 feet of cuttings. The total product to the end of the census year was $11,565.

The other mines of East cañon and vicinity are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Exchange and Sunnyside	1,000	$80,000	Assessment work done	
Lion	1,000	120,000	do	
Chloride Point and others on Silveropolis hill.			do	Several hundred feet of cuttings. Produced many thousands in early times.
Miner's Delight group	a 300		Worked on lease	Ore assays 19 ounces silver and 11 to 14 per cent. lead; sells for $7 per ton. Total product, many thousand tons; 1,200 tons extracted in census year.
Bonanza			do	Has produced considerable ore.
Cleveland Mining Company.	1,430	100,000		Ore assays $150 to $1,000 per ton.
San Joaquin	750	35,000	Worked irregularly	Ore assays $100 to $400 per ton.
Poorman	b 500	Small	Idle	Little ore ever shipped.
Buckhorn	a 200		Leased	Ore assays 20 ounces silver, 35 per cent. lead. Much ore formerly produced.
Mountain Gem and Antelope.	1,000			Surface ore assays 20 ounces silver, 30 per cent. lead. Several thousand tons shipped in 1877 and 1878.
California			Active	Ore assays 25 ounces silver, 55 per cent. lead,

a Incline; also other cuttings. b Drifts; also shaft of several hundred feet.

MINES OF DRY CAÑON.

The Hidden Treasure mine is situated on a steep hillside above and three-quarters of a mile northeast of Jacob City. It was located in 1865 as the Saint Louis lode by General Connor's soldiers, who had been told by Indians of the outcropping bowlders of galena. Little work was done until April, 1870, when it was relocated as the Hidden Treasure. The mine has been extensively but irregularly worked since 1872. It was idle during a few months preceding the writer's visit. The property consists of the Hidden Treasure, Saint Louis, Cedar, Summit, Red Line, Sacramento, Hidden Treasure East Extension, Columbia, and Western, all adjacent claims. The ore is found in one or two chimneys in a bedded vein in a compact bluish limestone, which dips about 30° N. 32° W. About 3 feet above the ore there is a contact vein an inch or so in width between an overlying stratum of siliceous slate (locally called "block slate") and the limestone beneath. Very rarely, however, does the ore body make to the contact (in some of the upper works the ore was on the contact). One chimney began at the surface, or at least within 60 feet of it, and continued for 600 feet. It then split into two chimneys, which continued 800 feet or more. The upper chimney was from 20 to 100 feet wide and from 3 to 20 feet thick. The branches were from 10 to 25 feet wide and from 1 inch to 20 feet thick. The ore found in the Chicago mine was in two bedded pipes, which were in a limestone stratum about 100 feet beneath these ore bodies. The pipes turned upward and finally connected with the Hidden Treasure vein. The ore of the Hidden Treasure is a soft reddish-brown ocher, containing cerussite, galena, and traces of copper carbonates. It assays from 15 to 40 ounces silver and 20 to 50 per cent. lead. A few hundred feet to the north of this mine, in the direction in which the ore-bodies dip, a great dike of granitic porphyry cuts through the country. The mine was formerly opened by five inclines, three of which were in ore, and several tunnels. It was worked at the period under review through a 500-foot tunnel, from which an 800-foot incline was sunk between the two chutes of ore. The extent of the workings on this stratum was 1,600 feet on the dip and 450 feet horizontally. Within this area there were probably 9,000 feet of inclines, drifts, and winzes. The ore chutes continue at the bottom, though small in places. Some seepage water was encountered and zincblende occasionally appeared. The steam hoisting works consist of a 40 horse-power horizontal engine with $\frac{7}{8}$-inch steel-wire rope in the tunnel at the top of the incline, and one horizontal boiler at the surface. Water for use in the boilers has to be purchased at 1 cent per gallon, except in the winter months, when snow is used. During the census year about twenty men were employed, at $3 per day, 10 hour day and 9-hour night shifts. There were 1,408 tons of ore produced, which assayed about 33 per cent. lead, 18 ounces silver, a trace of gold, with 7 per cent. moisture, selling for about $20 per ton at the Chicago smelter. During the four years ending April 1, 1878, 28,400 tons were mined. Most of this was smelted at the Waterman smelter at Stockton. The cash received for this amount of ore, whether sold as ore or as bullion, was $988,700. It was conceded that the mine made money, but that the smelter lost it. Several thousand tons of ore were produced prior to 1874.

The Chicago mine was located in 1871, and sold to an English company soon afterward. The mine was worked vigorously for several years, but has been idle since 1876. Ore was found in two pipes 60 feet apart in the "reef" of limestone under the Hidden Treasure. These pipes came to within a few feet of the surface, covered only by the iron cap, and diverged somewhat as they went down. They were in general about 2½ feet in diameter, but varied in shape considerably, especially beyond 400 feet. One pipe was followed 1,300 feet, and decreased in size until it was only 6 inches in diameter, when work was abandoned. This had five smaller pipes branching from it. The second pipe went down quite regularly for 800 feet, then suddenly rose 60 feet and continued on its course. A second rise brought it to the Hidden Treasure vein. The ore is ocherous, assaying from 25 to 35 ounces silver and

from 40 to 45 per cent. lead. On the sides of the pipe there is usually from 6 inches to a foot of a valueless oxide of iron, frequently stained by copper carbonates. The total cuttings amount to about 5,000 feet. The mine is furnished with a Hallidie wire-rope tramway 2¼ miles long to the wagon road in the ravine below. This gave great satisfaction, and was at the time of the writer's visit still standing. The mine produced considerably over 12,000 tons of ore. This company owns the Chicago smelter, and when the mine failed bought the Queen of the Hill, Flavilla, and Mahogany locations. These claims are on three chimneys in a bedded vein, from 1 to 6 feet wide, dipping 17° to 25° W. between a siliceous limestone above and a blue limestone stratum below. They were located in 1870–'71, and were worked extensively between 1873 and 1877, but very little since. Shortly after the purchase the Chicago company came to the fault and failed. The Flavilla Mining Company was then organized, and had just begun prospecting to find the vein beyond the fault. This group of claims was the most developed of any in the district, and is situated about half way up a large steep hill, 1 mile south of Jacob City. The dip of the chimneys is N. 30° W., being oblique to the dip of the strata. The distance between them is about 80 feet and 150 feet. Two faults were found, one along the line of the Mahogany chimney northeast and southwest, and the other nearly at right angles to it, faulting all the ore chutes and dipping a little northeast. This fault showed a fissure 20 feet wide, of which 4 feet on one side was calcite (locally called "water spar"), the remainder being filled with clay and fragments of country rock. The first chimney was 350 feet long (before being cut by the fault) and was from 25 to 40 feet wide, having a thickness of from 18 inches to 2 feet of ocherous ore containing but little copper, and said to assay from 20 to 25 ounces silver and 50 per cent. lead. The second chimney was 1,000 feet long, from 60 to 70 feet wide, and also had from 18 inches to 2 feet of ore, generally upon the hanging wall, assaying about 40 ounces silver and 30 per cent. lead. The third chimney was about the same size as the second, but the ore contained some tetrahedrite, much malachite, and little lead, and assayed about 60 ounces silver. The claims are opened by two main inclines 1,000 feet and 1,400 feet long and 6 feet square, which branch near the surface like the letter Y. The horizontal development is 1,200 feet. It is claimed that there are 8 miles of openings, but if the stopes were not counted there would probably be not over 12,000 feet. The hoisting works have a Copeland & Bacon vertical engine of 35 horse-power. A double-track tramway with ⅝-inch steel-wire rope extends several hundred feet from the mine to the bed of the ravine below. The product of these mines could not be ascertained. It was probably over $1,000,000, as 26,000 tons, assaying from 30 to 40 ounces silver, were shipped while Mr. Davis was the superintendent.

The Mono mine is situated half a mile south of Jacob City. It was discovered in the autumn of 1871, and was owned in its early days by Gisborn, Embody, Heaton & Miller. It was worked vigorously by them until 1875, when Gisborn bought the remaining two-thirds interest for $400,000, mortgaging the whole to eastern capitalists for the money. About three months after the sale a fault was found, or the ore chute "pinched", and only a small prospecting force was employed until June, 1879, since which time it has been idle. Ore began at the surface and was found in a chute from 10 to 50 feet long, from 3 to 5 feet wide, and 300 feet deep. Below that depth it was in a series of small deposits. It was an oxidized ore, from silver, lead, copper, and iron sulphides. Slabs of horn-silver were frequently found so soft that they would retain the impression of a coin like wax. Its value, by the ton, was from $150 to $5,000 in silver. This ore occurs in a stratum of clay shale. The ore chute seems to cross this stratum and enter a black shale at a depth of 400 feet. In the lower workings the ore was limited in quantity, and only assayed about $100 per ton. The main incline is 850 feet long, with an angle of about 33°. The greatest horizontal extent of the development was only 300 feet, but the total cuttings amounted to 2,000 feet. It was the opinion of many who were familiar with the mine that the dip of the incline was away from the ore chute. The mine had small hoisting works which cost about $12,000. The total product was not known, even by the original owners, as they divided the proceeds after the sale of each lot. By one it was placed somewhat over and by another somewhat under $1,000,000.

The Mono Tunnel site is in the ravine 800 feet below the Mono mine. Work was begun in 1872 or 1873. The tunnel is about 1,100 feet in length. Burleigh drills and an air-compressor were used. Only assessment work has been done for some time.

The Kearsarge mine, located half a mile west of Jacob City, was discovered in 1871, and has been idle for a few months. The ore-bearing formation is a stratum of limestone, in which the ore occurs in chimneys and exceedingly irregular masses. The overlying stratum or hanging wall is a very compact siliceous limestone. One chimney began at the surface and went down 500 feet. In this there was a chamber 70 feet long, 30 feet wide, and from 10 to 25 feet high. Three or four other bodies were found near the main chimney. In one of them several tons of $10,000 chloride ore were encountered. The ore is a soft ocher, similar to that of the Hidden Treasure, but much richer. The mine was opened by a 945-foot incline, having a dip of 30° to 35°. It was not prospected over 100 feet horizontally, but contained at least 3,000 feet of cuttings. The ore continued in the bottom of the incline 20 inches in width, but water had stopped the work. The hoisting rig consisted of a whim with a ¾ inch steel-wire rope. The total product was unknown; perhaps $1,000,000 had been received. Belonging to this property is the Jennie claim, having a 350-foot incline and 650 feet of other cuttings. A few hundred tons of 40-ounce ore were produced.

The Deseret group consists of the Deseret, Shoo Fly, Azure Queen, Ivanhoe, American Flag No. 2, and Thad. Stevens, overlapping claims. They were located in 1870–'71. Work on them was begun in 1874, and discontinued January 1, 1879. The Deseret claim has a 750-foot incline, following the chimney at an angle of 45°. There was little drifting. There are small, neat hoisting works, containing a 50 horse-power engine, and a Bowers air-compressor was used to run two Woods drills. The ore has a lime gangue, containing very little iron, oxide of lead, and assayed 70 ounces silver and a trace of gold. The Thad. Stevens has a 380-foot incline and about 250 feet of drifts. The ore of this chimney averaged about a foot in width, and assayed 35 per cent. lead and 30 ounces silver. The total production of the group was estimated at $30,000.

The other mines of Dry cañon are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Wandering Jew	4,200		Little work done	A few hundred tons of 30-ounce silver and 35 per cent. lead ore extracted.
Utah Queen	900		Assessment work done	Large amount of ore extracted.
Sacramento	800		Idle	Considerable ore taken out formerly.
Mountain Savage and L. X. L.	1,090	2,100 tons	Assessment work done	Ore assays 40 ounces silver and 25 per cent. lead.
Emporia	1,600	$30,000	Leased	
Fourth of July	a440	1,000 tons	Assessment work done	Ore assays 30 ounces silver and 35 per cent. lead.
Evening Star	350		do	Some good grade ore shipped.
Magnolia			do	Several hundred feet of incline and drifts. Much money spent, little received.
Rattler			Idle	Few hundred feet of work done.
Brooklyn			do	Do.
Elgin			do	
Noyes			do	

a Incline; also other cuttings.

There are many other claims having considerable development which are not mentioned, as they were not represented at the time of the writer's visit.

CAMP FLOYD DISTRICT.

[November, 1880.]

The Camp Floyd district is south of the Ophir district, and is on the same range. It is an irregular rectangle, from 7 to 9 miles on a side, the mines themselves, however, being included within an area of a square mile. Five hundred and ninety-five locations had been made, of which but twenty five were held at the time of the writer's visit. Aside from those employed by the Carrie Steele Company, not ten men had been working in the district during the preceding twelve months. The formation is a blue-black limestone, dipping from 10° to 25° NE. An exception to this is a stratum of quartzite or siliceous limestone (locally called a "reef"), from 25 to 75 feet thick, on which all the claims are located. Lewiston, the town of the district, is 18 miles southeast of Stockton, with which it is connected by a good wagon road. The Carrie Steele mine is about one-quarter of a mile from Lewiston, and is 7,000 feet above sea-level. It was discovered in 1873 by Leandro Steele; was worked from 1876 to July, 1879, when it was sold to the Carrie Steele Mining Company, of New York. This company has a capital stock of $1,000,000, in 100,000 shares. A working capital of $30,000 was raised by the sale of 20,000 shares. The ore in this reef outcropped in a single spot upon the hillside. The workings so far have been through three tunnels, and have explored a space not to exceed 50 feet in depth and 200 by 274 feet. The levels and drifts amount to 1,420 feet. One large body of antimonial ore, 20 feet thick and 60 by 70 feet in extreme width and length, was found at the surface. The richest ore averaged $700, and occurred in a seam from 8 to 10 inches wide, next to the roof. There are three crevices a few inches wide, parallel, and 30 feet apart, which ran NE. and SW. through the "reef". The secondary small bodies of ore were found on the northwest side and adjacent to these crevices. The ore is a hard, tough siliceous limestone, rarely soft and fine, sometimes much broken, and containing seams of oxide of iron and crystals of quartz and calcite. The silver is in the form of horn-silver, except in the case of the antimonial ore. This last ore seems to be an argentiferous stibnite, and assays from $100 to $500 per ton. The great mass, however, is low grade, from $15 to $50, until sorted, and is free milling. No water is found. In the census year about eighteen men were employed, and 1,500 tons of unsorted ore were produced. The sales of ore prior to the purchase by the present company amounted to about $80,000.

The mill is a wet-crushing 20 stamp silver mill, having eight pans and four settlers. It was built by an English company in 1872–'73 to work the ores of the Sparrowhawk mine, and was said to have cost $80,000. It was purchased by the Carrie Steele Mining Company in 1879, and ran from May 10 to August 15, 1880, since which time it has been idle. The mill is a quarter of a mile from the mine. The cost of hauling ore was 75 cents per ton. Owing to scarcity of water, which was brought 2¼ miles in a pipe, it was pumped from the settling tanks and flowed again through the battery. Ore was worked with salt and sulphate of copper. This method is said to save 83 per cent.

of ordinary ore and 60 per cent. of the antimonial ore. Tailings assayed $6. The cost of milling per ton was said to be only $5. Probably a long run would materially raise these figures. The mill had an Aiken furnace, which was not used.

The other mines of the Camp Floyd district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Sparrowhawk	6,000	$300,000	Idle	Ore similar to that of the Carrie Steele.
Star of the West	500	None	do	No ore shipped.
Silver Circle	1,000	Small	do	In 1873 many thousand dollars spent in prospecting.
Silver Cloud	800			Formerly shipped a few hundred tons of $30-ore.
Mormon Chief	1,000		Idle	Little done since 1875.
Elkhorn	550	$50,000		

Cinnabar.—Above the ore-bearing quartzite stratum is a 30-foot stratum of siliceous limestone. This contains cinnabar in seams, cavities, and in the solid rock. Reports conflicted as to the thickness of this bed, the estimates varying from 12 to 40 feet. Some very rich specimens had been obtained, but it was not thought that the mass would average over 1 to 2 per cent. of quicksilver. There are several claims, the principal of which are the Geyser and the Jenny Lind. The developments are very limited, no attempts having been made to reduce the ore. This district and Marysville, Pi Ute county, are the only localities in the territory where cinnabar has been discovered.

TOOELE MINING DISTRICT.

[November, 1880.]

The Tooele district is situated on the western slope of the Oquirrh range opposite the West Mountain district. It was organized in 1870, and contained 120 claims. The organization, however, has not been preserved, and all claims are abandoned except the Clipper, Rob Roy, and a few others. The Clipper consists of a single pipe of ore in quartzite, from 2 inches to 5 feet thick, and from 2 to 10 feet wide, and has been developed by a 600-foot incline. The total yield is estimated at $10,000. The Rob Roy has 300 feet of openings, from which a few tons have been shipped. Both these mines are worked irregularly.

In the neighborhood of Tooele City there are 12 stone bee-hive kilns, constructed at intervals between 1874 and 1880. They are run irregularly by Mormon owners, who sell the charcoal produced to Stockton smelters.

GRANTVILLE, OSCEOLA, GREELEY, BOULDER, COLUMBIA, OASIS, DESERET, GRANITE MOUNTAIN, CLIFTON, AND LAKESIDE DISTRICTS.

The Grantville district is situated on the eastern slope of the Onaqui range and was organized in June, 1875. There are but few claims, mostly undeveloped. The Third Term is the principal mine. It is 8 or 10 miles southwest of Grantville. So far as known, it consists of a large chimney, 14 feet square in places, of "hard carbonate" low-grade ore in limestone. Work was begun in 1877, and $15,000 has been spent in prospecting the claim. It has a 450-foot incline and 600 feet of drifts, and a 600-foot tunnel (not completed) is being run to cut the chimney at a great depth. The ore is a smelting ore carrying from 10 to 15 ounces silver. A few hundred tons have been sold, yielding $2,000. There are several thousand tons of low-grade ore in sight. In the census year, fourteen men were working six months. The Osceola has several hundred feet of cuttings, showing some copper and silver ores.

The old Osceola, Greeley, and Boulder districts, situated south of the Camp Floyd district, had but few locations, and were abandoned some years ago.

The Columbia district is 9 miles southwest of Vernon, and was organized in 1871. There was some excitement here in 1871 and 1872, and again in 1875 and 1876. In 1875 an Ohio company spent a large amount of money very recklessly and failed. The country rock is limestone, quartzite, and slate. The veins are usually large, averaging from 3 to 4 feet; but the ore is too low grade to pay at that distance from a market. It was said to average from 10 to 25 ounces silver and from 30 to 40 per cent. lead. Several hundred tons have been shipped. The developments are, as a rule, very limited. Only about ten claims have kept up assessment work.

The Oasis district was called North Tintic in 1873, Caledonia in 1875, and was given its present name in 1879. There are, probably, twenty locations in force. The ore is milling and smelting of varying grade. There is very little development. Wood and water are plenty.

The Deseret district, in the desert west of Columbia and Oasis districts, contains one strong copper vein, from 1 foot to 3 feet wide, in granite. The ore is low-grade in copper and silver, and the developments are nominal.

The Granite Mountain district is on a mountain in the same desert as the above district, and still farther west. There are said to be a few very narrow veins of rich silver ore in granite. There are three good springs of water in the district. A California company did considerable unprofitable work here years ago.

The Clifton district is situated on the borders of Nevada and Utah, 3 miles northeast of the Deep Creek Indian reservation, and 70 miles southeast of Toano, Nevada. It was organized in 1869 or 1870. A smelter was built in 1871, and was moved in 1876 to a spot 6 miles distant by the Saint Louis Consolidated Company. Probably 150 tons of bullion were produced in the various runs. The country rock is said to be limestone and granite. There are numerous veins of gold quartz from 2 to 10 feet wide, claimed to average $15 per ton, and some small veins containing galena and pyrite ore. About 50 claims, of over 500 located, are still worked occasionally. Little has been done since 1877.

The Lakeside district is situated on the southern and western shore of Great Salt lake. The excitement here was from 1871 to 1874. Little has been done since. There are a number of mines, about 2 miles from the lake and on a ridge 500 feet above it, which contain large bodies of ore assaying from 6 to 15 ounces silver and from 50 to 70 per cent. lead. The country rock is limestone. A large amount was mined and shipped across the lake, but not profitably.

JUAB COUNTY.

TINTIC DISTRICT.

[September, 1880.]

The Tintic district is situated on a range of high hills, a continuation of the Oquirrh mountains, about 70 miles S.SW. of Salt Lake City. It extends 10 miles east and west and 15 miles north and south, and contains the three mining camps of Silver City, Eureka, and Diamond. It was organized December 13, 1869, and the records showed 3,000 locations. Probably not over 500 are claimed, and less than 100 are developed to any extent. The elevation of the claims will vary from 5,500 to 7,000 feet. The winters are very mild, and mining operations can be conducted during the whole year. The country rock is porphyry on the east, and limestone and quartzite on the west. There are three prominent mineral belts: the Mammoth-Eureka, Sunbeam, and Julian Lane, besides many smaller veins or disconnected deposits. This district was quite active prior to 1876, but most of the work since has been upon a half dozen large mines. The total production of the district can hardly be estimated, owing to the number of old and abandoned reduction works and the numerous changes in their management. A rough estimate would place it at something less than $2,000,000. The reduction works in the district have been as follows:

Clarkson smelter.—Two stacks. Erected at Homansville in the summer of 1871. Smelted ore from the Scotia, Swansea, and Eureka. Produced a few hundred tons of bullion. Shut down in 1872 and moved away. Dump has been sorted over two or three times with good results.

There were two smelters at Diamond, long since removed; one made a successful run of several hundred tons of bullion.

One smelter, copper and lead, was erected in 1873 near the present Crismon-Mammoth mill. It worked about 1,000 tons.

Eureka mill.—12 stamps. Erected at Homansville in 1871–'72. Very little work done. Removed.

Miller mill.—10 stamps. Erected in 1872. Ran a year and a half. Dismantled.

Copperopolis mill.—15 stamps. Built in 1872–'73.

Copperopolis copper smelters.

Shoebridge mill.—15 stamps. Built in 1873.

Wyoming mill.—10 stamps. Built in 1873.

Crismon-Mammoth mill.—27 stamps. Built in 1879.

Latham's furnaces (2).—Erected at Goshen in the fall of 1874. Ran at intervals for six months, producing 7½ car-loads of bullion and one of copper matte. Were unsuccessful and are dismantled.

Leaching works.—Built at the same place in the spring of 1876. Worked about 250 tons of ore, only averaging 40 per cent. of assay value.

Leaching was unsuccessfully attempted in the spring of 1879 in small, rude works fitted up in the old Miller mill.

At the period under review most of the mines shipped their ore from 20 to 30 miles to Santaquin, a station on the Utah Southern railroad, at a cost of from $2 75 to $3 50 per ton, and thence by rail to the Sandy smelters. Owing to the absence of some owners complete statistics and descriptions cannot be given.

The Mammoth-Copperopolis mine was discovered in 1870, and was sold the following year to an English corporation, the Mammoth-Copperopolis Mining Company, for a large sum; reports vary from $60,000 to $600,000. A large amount of copper ore was shipped to England, and a 15-stamp mill and two copper smelting furnaces were erected in 1873 7 miles south of the mine. The mill ran a few months, and then shut down. The copper smelters made matte for some months longer, and have made occasional campaigns since. The company failed in 1873, and the property was sold for debt. It was redeemed by Lord Hamilton, and the British Tintic-Mammoth Mining Company (limited) was formed in the fall of 1878. The property has been worked irregularly since. It was idle at the time of the writer's visit, but from information given by the foreman the writer is enabled to give the following brief description: The mine is patented, and is 1½ miles north of Silver City. It is a mineral belt, from 50 to 100 feet in width, dipping 70° W., between strata of dolomite or limestone. The gangue is a siliceous limestone, usually strongly impregnated with oxide of manganese. The ore occurs in bodies of all shapes and sizes from an inch to 20 feet in width. Five large deposits have been found, the largest one, which began at the surface, being from 10 to 25 feet wide by from 60 by 70 feet. The ore is hard, tough, and siliceous, containing malachite and, in the lower workings, some sulpharsenide or sulphantimonide of copper. The ore is supposed to average from 5 to

8 per cent. copper, from $8 to $11 gold, and from $15 to $35 silver. This is but a mere guess, not being based on actual working tests of large lots of ore as it comes from the mine. At all events, there were in the mine large lots of low-grade ore. Besides surface work, the mine is opened by two tunnels, 350 and 270 feet, through the hanging wall of the belt. The total cuttings do not exceed 2,000 feet. No water has been found. The total product is unknown. It is estimated that about 5,000 tons were shipped. The mill, containing fifteen 750-pound stamps, eight small pans, and four settlers, was built in 1873, and, at the period under review, was in fair condition. The water supply was, however, not sufficient to run it.

The Crismon-Mammoth mine was discovered in 1870, and has been worked, at least by a small force, continuously since. The mine was considered a copper mine only until the summer of 1875, when silver was discovered. In August, 1876, gold was also found in the bullion. Copper ore was shipped to Baltimore prior to 1874. Between July, 1876, and September, 1877, ore was shipped to the Homansville mill. The company's mill was then built. The mine is situated on a steep hillside at the head of a short ravine a mile and a half north of Silver City. It is supposed to be the continuation of the Mammoth-Copperopolis belt. The known dimensions of the ore-bearing formation, extreme limits, are 70 feet wide, 450 feet deep, and 500 feet long. The belt is in dolomite, dipping 75° W. The ore occurs very irregularly in the vein, in all shapes and sizes less than 25 feet in extent. There seem to be three veins in the belt, with barren spaces or horses between them. About half the ore is a coarse, tough siliceous rock stained with malachite and azurite in seams and cavities. The remainder is firm, and consists of crystals of calcite with oxides of iron and manganese. Very little of the silver contents is in the form of a chloride. At the time of the writer's visit the ore was worked for the gold contained, which was nearly equal to the silver value. There are large masses of ore, many thousand tons, exposed by the various openings in the mine. Until lately few timbers have been used. For several years the mine had worked rather with a view to its present prosperity, only the richest ore being taken out. Timbering was being done with square sets. Round timbers were employed from 9 to 12 inches in diameter; 8-foot posts, 8-foot ties, and 7-foot 6-inch caps. The mine is dry, and is worked entirely through two tunnels, 100 and 440 feet long, which cut the belt 80 and 240 feet below the croppings. The total openings are about 4,000 feet in length. About ten men were employed during the census year, and 3,448 tons were sent to the mill by four- and six-horse teams at a cost of $4 50 per ton. The production in early times is unknown. A rough estimate places it at from $50,000 to $75,000 for the copper ore sold. Between June, 1874, and June, 1880, $301,430 87 was received over and above the express charges and bullion discount. Of this amount $81,000 was estimated to be for silver, $189,000 for gold, and the remainder for copper. In addition to this it was claimed that $100,000 in gold specimens was stolen when a fabulously rich band of gold ore was found. The dividends paid between June, 1874, and June, 1880, amounted to $109,205 16.

The mill is situated in Tintic valley, 8 miles south of the mine. It is a 27-stamp mill, consisting of 5 stamps from Ophir, 10 from the Miller, and 12 from the old Eureka mill. It was constructed between December, 1876, and February, 1879, and crushed wet until March, 1880. A White & Howell furnace was then added, but was soon shut down. Wet-crushing was again begun in August, 1880. But little systematic assaying has been done, and but few records kept. The apparatus of the mill consists of seventeen 750-pound stamps, ten 550-pound stamps, a rock-breaker, five pans, three settlers, a White & Howell furnace, and a retort. Twelve of the stamps are in batteries of four each. The drop is 6 inches, single discharge, Nos. 50 and 60 brass-wire screen, speed 90, and capacity from 30 to 40 tons in twenty-four hours. The pans are charged with bluestone and salt, and run from six to eight hours. The bullion is very base, containing much copper. The tailings, of which there were several thousand tons on hand, are said to assay $9 and over in gold and silver. The White & Howell furnace is a very fine one. It has a 24-foot cylinder, 60 and 50 inches in diameter, with flue-dust chambers 60 by 14 by 9 feet. It ran but a short time, and, while giving good results in chloridizing the silver, is said to have "rendered the gold less free". No reliable data could be obtained.

The Eureka Hill mine was discovered in 1870. In 1871–'72 a 12-stamp mill, without a furnace, was erected, which would not work the ore. In 1873 the property was sold for several hundred thousand dollars. Final payments, however, were not made, and the property reverted to the original owners. There have been many legal complications about the ownership of this property, and a stone fort was once regularly garrisoned to defend it. In early times ore was worked at the Homansville smelter and at the Shoebridge and Wyoming mills. Later it was sold to the smelters at Sandy. Since July, 1880, much of it has been shipped to the Tintic mill at Homansville. The property comprises two patented claims, the Eureka and the Montana, 2,200 by 200 feet each, and was owned, at the period under review, by a close corporation called the Eureka Mining Company. These claims are on two nearly parallel veins, about 100 feet apart, which dip from 80° to 85° W., and strike nearly north and south. Between them are found connecting pipes and ore bodies, and together they constitute a mineral belt which is supposed to be a northern extension of the Crismon-Mammoth, but separated from it by a great fault. This belt runs along a spur from a high steep ridge, on which the ore outcropped in several places many feet long and wide, and running under a narrow valley outcropped again on the opposite ridge several thousand feet distant. About 300 feet north of the southern boundary of the company's ground these two veins unite. From the point of junction northward for several hundred feet there is an extremely hard compact horse or block of dolomite country rock between the two veins. At the north end of this horse the gangue is much broken, and chimneys and seams of ore running in all directions are

found. This gangue is a tough siliceous limestone, much of which is impregnated with oxide of manganese. Apparently the lime and magnesia have been replaced in part by silica and oxide of manganese from solutions. The ore is very similar to the gangue, but is generally stained with carbonates of copper and some oxides of iron. In one part of the lower works oxide, carbonate, and sulphide of lead are found with traces of pyrite and zincblende. A small percentage of the silver is chloride. Gold occurs in places. There is one large chimney of hematite. In general, the ore and gangue shade insensibly one into the other. If the ledge matter is compact it is low grade, but if it is open and seamy it is good ore. There are large breasts of ore in the mine, which, it was claimed, would average from $30 to $40 silver per ton, and some gold. Most of the ore contained a small percentage of copper. In the old dumps on the ridge there are several thousand tons of ore, rejected in early days, that would probably assay $25 per ton. On the surface some wonderfully rich ore was found, and large bodies in the mine have averaged from 60 to 100 ounces in silver. Comparatively little ore is being extracted, considering the many thousand tons of ore in sight, and that only of the highest grade. The company intends to prove the mine and to see how much and what kind of ore has to be dealt with before erecting reduction works. The bodies of ore found are of all shapes. Several upon the surface are from 2 to 20 feet wide, from 15 to 75 feet long, and from 10 to 50 feet deep. Few of the bodies in the recent workings have been developed to any extent. They show ore from 10 to 20 feet wide. The extreme limits of the explorations on the belt are 680 feet of depth below the croppings, 100 feet of width, and 1,000 feet of length on the surface. No water is found. The mines are developed by several tunnels upon the belt and by two vertical shafts. The main shaft is a two-compartment shaft on the edge of the valley between the two veins. It is 280 feet deep, and is well timbered, but only a horse-whim is used on it. The total cuttings are estimated at 5,400 feet. About twenty-five men were employed during the year, working 10-hour shifts, at $3.

The No. 5 or Walton claim, and the Nos. 6, 7, 8, and 9 on the ridge, are southerly extensions of these claims. They contain over 1,000 feet of irregular work, and shipped considerable high-grade ore in early times.

The Ely mill was built by the Shoebridge company in the fall of 1873. It ran irregularly as a custom mill until February, 1877, when the company failed. The Hunt & Douglas process was introduced in 1876. The property was bought by S. P. Ely in 1878, who ran it as a custom mill between October, 1878, and September, 1879. It had been idle since that time, but the superintendent expects to resume work shortly. The machinery consists of an 80 horse-power engine, a Blake rock-crusher, a drying floor, fifteen 750-pounds stamps, six pans, three settlers, a clean-up pan, an Aiken furnace (not used), a Stewart five-hearth reverberatory, and a complete plant for the Hunt & Douglas process. The battery is double-discharge, dry-crushing, 8 inches drop, speed from 85 to 90, No. 40 screen, and 20 tons capacity. The guides are peculiar. They consist of hollow cylindrical iron tubes having a perforated screw-cap fitting the upper end. The tubes are filled with rawhide rings, and the cap is screwed down as the hide wears. They give satisfaction. The five-hearth reverberatory is 66 feet long and 12 feet wide, having a fire-box at each end and the flue on one side at the center. On the other side at the center is a projection like a bay window, and over the center is a hopper filled by a screw-conveyer, from which ore is fed into the furnace. The five hearths are separated from each other by a jog the thickness of a brick; the "warming hearth" in the center; two "oxidizing hearths", one on each side; and two "chloridizing hearths" between the "oxidizing hearths" and the fire-box. The arch over the "warming hearth" is 10 inches, that over the "oxidizing hearth" 18 inches, and that over the "chloridizing hearth" 36 inches high. The charges are 1,200 pounds every one and a half hours. The "warming hearth" has a new charge every one and a half hours, and the others every three hours. Hence the capacity of the furnace is 9½ tons per day. Ten per cent. salt is added one and a half hours before drawing the charge. The labor required is two men per shift. The process used at the mill, to a limited extent, is to crush dry, roast with salt, treat by Hunt & Douglas's method for silver and copper, and then amalgamate in pans for gold. Sometimes amalgamation is performed first, and the tailings, if assaying over 12 ounces per ton, are then treated by the Hunt & Douglas process. The theoretic and practical details of the process have been published many times, and it is not necessary to repeat them here. (See U. S. Mg. Comm. Report, 1876, page 395.) No complete and reliable data relating to the actual treatment of large quantities of ore by this process can be furnished in this case, as such data were not kept and the mill is not run regularly. The Hunt & Douglas plant at this mill has a capacity of about 10 tons per day, and consists of the following: The building, 80 by 45 feet; six agitator tanks, 9 feet in diameter and 5 feet high; six leaching tanks, same size; five store tanks above agitators, 7 feet in diameter and 6 feet high; three box vats for filters, 2½ feet square and 14 feet long; fourteen silver-precipitating tanks, 4 feet in diameter and 26 inches deep; and sixteen copper-precipitating tanks, same size. The floor of the tank-room is made tight and smooth by cement, so as to catch the drippings, which are conducted in a gutter to a cemented cistern in the ground. The amount of solution in use is about 30,000 gallons. The silver and copper left in the tailings is 4 ounces and less than 1 per cent., respectively. A pump attached to the lower part of the leaching tanks shortens the time required. After working some Golden Treasure ore, which was known to contain considerable bismuth, the solution became very cloudy and bad, and did not clear for a month. The necessary force is six men per shift, two leachers, two roasters, and two roustabouts. The mill offers to purchase or work ore at the following rates: 80 per cent. of the assay value of the ore in silver and copper, plus 50 per cent. of the assay value of the gold, if over $5 per ton, less $25 for working. The above amount is given in bullion, or the bullion is bought at the market price. These rates seem very liberal when compared with those in some

other districts, but they were not quite low enough to suit the miners. There are large bodies of low grade ore in the district containing gold, silver, and copper, and free from objectionable minerals as far as known. The writer does not know of a process more suitable for these ores. The copper usually wasted, which this process saves, would ordinarily pay more than half the expense of milling.

The Golden Treasure mine is on the northeast slope of Chloride hill, 2 miles southeast of Silver City. It was discovered in 1871. Owing to lawsuits with the Mayflower, Lillian, and Gold Hill claims, little was done until 1875. It was then extensively worked until the spring of 1879. It was idle until July, 1880, since which time it has been worked by three men. The claim is located on a belt of quartzose rock, 100 feet or more in width, in a porphyritic rock or, at least, adjacent to it on the west. The dip is 80° E.SE., and the prominent quartzite croppings extend several thousand feet. The ore is found in chimneys, five of which occurred near the hanging wall. One body came within 20 feet of the surface, one was exposed, and the others were not within 150 feet of the grass. One body was 60 by 70 by 20 feet, and one was 150 by 100 by 5 feet. The chimneys were from 1 foot to 10 feet (average 3 feet) wide, from 10 to 40 feet long, and were known to extend from 150 to 250 feet in depth. They dipped in all directions in the belt. On the east side of this belt is a vein of ocher from 1 foot to 10 feet wide, which gives assays of from 10 to 32 ounces silver, and from $5 to $15 gold. The ore is a very soft, fine-grained, light yellow clay ocher, which is said to mill freely. Average assays of first and second class show 65 and 35 ounces silver, respectively. All the ore contains a few dollars in gold. Occasionally, small bodies of a few pounds each of a soft, light-blue substance, assaying from 20 to 50 per cent. bismuth and several hundred ounces in silver, are found. The bismuth is doubtless in the form of an oxide or carbonate, and results from the decomposition of some sulphide compound. The mine is dry, but from the water-level in adjacent claims it was judged that water would be encountered in 50 feet. The property is developed by a 380-foot incline, from which levels and some cross-cuts have been run every 100 feet. The drifts on the belt extend 528 feet. The cuttings aggregate 2,570 feet. Ore is raised by a whim. The total product was estimated at 5,500 tons, containing 45 ounces silver per ton.

The other mines of Tintic district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Bullion	315	$10,000	Worked irregularly	
Bonanza	800	..	do	During census year 88 tons were sold at about $55 per ton; ore assays $90 27 silver and 19 per cent. lead.
Banner	365	1,500	Idle	
Woodmansee		100 tons		Developments limited.
Kinsey Ground	900		Idle	Worked continuously from 1869 to 1877. Average assay of ore, $50 to $70 per ton.
Sunbeam	a 310		Eight men at work	Several hundred tons of ore shipped.
Elmer Ray	1,500	$20,000	Nine men at work	Average assay of ore, $40 silver and $20 gold.
Julian Lane	3,000	4,000 tons	Idle	Much of the ore assayed $200 per ton.
Tesora	530	$200,000	do	Ore assays 25 to 80 ounces silver, $20 and under gold, and 10 to 15 per cent. copper.
Golden Bell				A few hundred feet of workings. Some ore shipped. In fall of 1879, 600 pounds shipped to Europe assaying $495 silver and 56 per cent. bismuth; sold for 75 cents per pound.
Lady Aspinwall	1,000		Idle	Many hundred tons extracted in early times.
Windigo M. Co		Very small	Little done	Vein wide, but little ore found.
Silver Spar	610	$15,000	Idle	Ore assays 75 ounces silver and 22 per cent. lead.
Shower	800		Worked on lease	Product, several hundred tons. Ore assays 50 ounces silver and 45 per cent. lead.
Morning Glory	650		Active	A few hundred tons have been produced.
Sunbeam No. 2		None	Idle	Many hundred feet of openings. Many thousand dollars expended.
Parke	2,000	40 or 50 tons	Eight or ten men at work	Ore assays: first class, $30 silver and 45 per cent. lead; and second class, $20 silver and 25 per cent. lead. But little ore has been shipped.
Swansea	2,400	1,000 tons	Three men at work	Average of assays, 70 ounces silver and 38 per cent. lead.
Carisa	425	25 tons	Four men at work	Ore assays 70 ounces silver, 12 per cent. lead, and $7 gold.
Rising Sun	630	30 tons	One man at work	Thirty-four assays averaged $68 per ton.
Lucky	760		Idle	Shipped considerable ore.
Undine			do	Much work done and much ore extracted in the past.
North Star	350		do	Average assay of vein, $20 per ton.

a Shaft.

In addition to the above claims, there are many others, having several hundred feet of developments, which had shipped ore, but were idle at the time of the writer's visit. (For a description of the Tintic mill see Utah county, page 446. The mill belongs to this district, but is situated a few miles over the county line.)

TINTIC IRON MINES.

Large deposits of hematite and limonite iron ore are found in this district, on Black Dragon hill, three-fourths of a mile east of Silver City; and in Black Stallion gulch, 6 miles east of Silver City. Formerly the Sandy smelters obtained their iron flux from near Rawlings, Wyoming. In late years, however, it has all been obtained from the two above-mentioned localities. The business is managed in the following manner: The Utah Forwarding Company pay $1 25 for Black Stallion ore and $1 50 for Black Dragon ore on the dump. Mormon teamsters from the adjacent settlements haul Black Stallion ore 16 miles to the railroad at Santaquin for $2 50 per ton, and Black Dragon ore 25 miles to the same station for $3 25 per ton. The Forwarding Company then sell it to the smelters at private rates, varying from $7 to $8 per ton. The mine owners lease the mines at a royalty of from 25 to 50 cents per ton, or hire miners, giving from 75 cents to $1 per ton for extraction. The miners make from $2 to $2 50 per day. An average of eighty men were employed during most of the census year, and seventy-five teams for ten months. Black Dragon ore contains about 55 per cent. iron, and is called first class. Black Stallion ore had only 45 per cent. iron, and is known as second class. Each kind contains traces of gold and silver. During the census year 2,112 tons of first class and 10,611 tons of second class ore were shipped.

BLACK DRAGON HILL MINES.—There are many places on the south side of the hill where the ore, principally hematite, comes to the surface in a "blow-out" 200 feet or more wide. It is here in open cuts that the iron is obtained. A tunnel 600 feet long was run from the ravine at the base of the hill, in the expectation of finding a body of silver ore. The iron vein, where it was cut, was from 25 to 30 feet wide, between limestone and porphyry. Between the iron and the porphyry is a stratum or vein of kaolin from 20 to 100 feet wide. In places it has a blue or yellow tinge, but for many feet it is almost milk-white.

BLACK STALLION GULCH MINES.—These mines are in an area three-fourths by one mile in extent. The belt trends east and west, and is on the line of contact between limestone and porphyry country. The following notes notes were furnished by one of the owners:

Black Stallion.—This mine had shipped ore for eight years, sometimes 300 tons per month. It had an open cut 70 feet long, 25 feet wide, and 30 feet deep, and plenty of ore at each end.

Iron Queen.—Continuation of the Black Stallion. Cut, 35 feet deep. Had shipped ore for five years.

Red Chief.—Developed by a surface cut 300 feet long, 30 feet deep, and from 4 to 15 feet wide.

Mountain Chief.—Developed 200 feet in length, 15 feet in depth, and 10 feet in width.

Vulture.—Large open cuts; 200-foot tunnel; vein, 30 feet wide.

Borrisson.—Surface cut, 200 feet long and 30 feet deep.

Sailor Boy.—Surface cut, 200 feet long, 15 feet deep, and 30 feet wide.

Snell.—Open cut, 300 feet long, 30 feet deep, and from 10 to 12 feet wide.

Iron Star.—Open cut, 250 feet long, 15 feet deep, and 15 feet wide.

All of these mines had shipped large quantities of flux during the year. There were also thirty other flux mines of smaller size which had shipped small quantities.

WEST TINTIC, DUGWAY, AND MOUNT NEBO DISTRICTS.

[September, 1880.]

The West Tintic district is situated from 16 to 20 miles west of Tintic district. It was organized in 1870. Considerable work was done in 1872 and 1873. There have been a hundred or more locations, of which about twenty are held. The country rock is limestone, quartzite, and granite. The veins are usually large, and contain low-grade galena and carbonate ore, assaying from 12 to 20 ounces silver and from 25 to 40 per cent. lead. Very little has been done on any of the claims except the Scotia. In early times this mine shipped to Homansville and Stockton several hundred tons of 70-ounce ore. Wood and water are plenty. The country is a good stock range, and about fifteen men divide their time between mining and pastoral pursuits.

The Dugway district is 60 miles or more west of Tintic district. It was organized in 1872. A few years later a smelter was erected. There are said to be large quantities of galena ore, low grade in silver. There are few locations, and the district is practically abandoned.

The Mount Nebo district was organized in 1870. It is situated on the western slope of Mount Nebo and the adjacent portions of the Wasatch range, extending 15 miles north of Salt Creek. About 130 locations have been made, 10 of which have received considerable attention, and are still held by yearly assessment work. The country rock is limestone. The ore is an ochery carbonate and galena, assaying from $10 to $30 silver and 55 per cent. lead, and occurs in narrow-bedded veins. The principal claims are the Olive Branch, Mount Queen, Germania, and Centennial, each having a few hundred feet of cuttings. Only 30 tons of ore have ever been shipped, but, as a Mormon said, "there must be a big ledge there somewhere, for the country is just covered with croppings."

ROCK-SALT MINES.

In Salt Creek cañon, 7 miles northeast of the town of Salt Creek, is the Salt Cave mine. It was a small cave from which Indians formerly obtained their salt. The mine consists of an open cut from the level of the bed of the ravine into the bank, 30 feet deep, 75 feet wide, showing a face of impure salt 25 feet high. From short tunnels and shafts through the adjacent drift this had been proved to be a bed of salt having an unknown dip and thickness. The salt is sometimes crystallized in transparent cubes several inches on a side, but it is usually contaminated with a very fine brick-red clay, and would not show over from 75 to 80 per cent. of pure salt by analysis. The overlying stratum is a fine, blue, sandy clay. The salt is mined with a gad and sledge or by blasting with black powder. It is sold for $4 per ton on the dump to the mills at Pioche, Silver Reef, Tintic, and formerly Park City. About 5,000 tons had been sold. There is another similar rock-salt deposit 6 miles farther up the cañon, which had produced considerable salt. There are also a few salt springs in the neighborhood which are worked irregularly in a small way by boiling down in a vat or by solar evaporation.

GYPSUM.

This mineral is very abundant in Utah. There are small hills of it near Fillmore, Millard county, and beds of it in Sevier, Iron, and Beaver counties; but it is only mined about 1 mile east of the town of Salt Creek. At this place a bed of it, from 50 to 60 feet thick, dipping 75° W. between strata of calcareous shale, is cut into by a cañon, and exposed for 170 feet in height. It is of the fibrous variety, and is in some places pure and white. It is used for the manufacture of plaster of paris in Salt Lake City. Sixty tons, worth $5 per ton at the railroad, were shipped during the census year.

SEVIER COUNTY.

ROCK-SALT DEPOSITS.

In a space of 16 miles along the eastern edge of the Sevier River valley, opposite the town of Salina, there are several places where rock salt is found at the surface of the ground—at Willow creek, Salt Gap, Salina cañon, and Lost creek. The Willow Creek salt bed, 7 miles north of Salina, is the most important, and has been known and occasionally worked since 1850. It is an irregular group of low red mounds, 400 feet wide and 900 feet long. These mounds are made up of the fine brick-red clay, sometimes containing fragments of sand and gypsum, remaining after the large masses of salt have dissolved. Sometimes this red clay is many feet thick over the salt, and at others the peculiar icy feeling of salt can be noticed after striking a pick into the hills. The country rock overlying and underlying this salt bed is a sandy shale. Salt has only been mined in two places, 30 feet square and 20 feet high, on a small hill. It seemed to be of the best quality, and was obtained by blasting. The other beds are similar, but not so extensive. Doubtless there is a great salt stratum extending along the side of this valley, but only cropping out in the above-mentioned places. These salt beds are not even claimed, but the roads to them are owned, and a charge of from $1 50 to $2 per ton is made for blasting out the salt and the use of the road. The crude material, as it stands in the bank, is supposed to average from 60 to 75 per cent. salt. Only the best, that containing from 70 to 90 per cent., is shipped. The market has been Pioche, Nevada, and Silver Reef, Utah. The total production is estimated at 1,200 tons, and that of the census year at 300 tons. There are some salt springs in the neighborhood, and some small rude salt works, where the rock salt is dissolved, settled, and boiled down, producing 30 tons of table salt per year.

MILLARD COUNTY.

SOLAR SALT MARSH.

The Solar salt marsh is in the northwestern corner of the county, 80 miles west of Deseret station, on the Utah Southern railroad extension, and is 6 miles long and from a quarter of a mile to 1¼ miles wide. It has been owned and worked since 1872. The salt has been shipped to Pioche, Ward, and Cherry Creek, Nevada. In the spring the marsh is covered with water, which, upon evaporation, leaves an efflorescent crust of salt several inches thick. It is shoveled into wagons without cleaning. The average yearly yield is said to be 500 tons.

Considerable salt is also collected in dry seasons on the borders of Sevier lake.

SALTPETER.

Saltpeter occurs in caves in lava near an old crater 14 miles west of Fillmore. There are five or six caves 25 feet wide, 100 feet long, and from 8 to 15 feet high. The floors are covered with a guano, in one place of a thickness of 3 feet, which analyses have shown to contain from 7 to 20 per cent. of niter. There is a small spring 1 mile from this place, but no attempts have been made to work it. Some niter was made by Mormons in 1855 from guano in similar caves in Washington county.

SULPHUR BEDS OF GORDON MINING DISTRICT.

The Gordon mining district is in the southeastern corner of Millard county. Cove Creek Fork, the town of the district, is 25 miles north of Beaver. It was organized in 1872. A few locations, showing traces of silver, had been made. No work of consequence was done on them, and at the period under review it was solely a sulphur district. The sulphur beds are 22 miles east of Black Rock, on the Utah Southern railroad extension, and are 6,500 feet above sea-level. The first sulphur discovery was the Cleveland claim, in 1870. It is situated on a small flat 3 miles south of the other claims, and is said to contain a small mound having large quantities of crude alum. It is 50 acres in extent. The remaining fourteen claims are 1,500 by 600 feet each, and were discovered in 1872. They all occur in a triangular area, 1½ miles on a side, where the slope of the hillsides terminates in small flats. The beds seem to extend into or under the adjacent hills of quartzite and siliceous limestone. There is an old crater about 4 miles to the southwest of the group of claims. Only three outcropped, the remainder being discovered by the whitish appearance of the surface, which the scarcity of vegetation disclosed. The sulphur is found from 2 to 12 feet below the surface, covered by surface gravel and a layer of whitish earth (acid-eaten rock), containing fragments of quartzite and gypsum. In some places it is quite pure, and to all appearances the beds should average 50 per cent. sulphur. In two beds there are crevices through which issue streams of warm air containing much sulphurous acid gas. The size of these deposits, as far as proved by small openings, is from 2 to 20 acres; but they may extend several hundred feet beyond the known limits. A shaft had penetrated the sulphur in one bed 16 feet, but in no place had it been bottomed. The developments consisted of a few cuts and holes at each deposit, done as assessment work. No sulphur had been shipped, except a few tons for sheep-dip and for local leaching works.

DETROIT, SEVIER LAKE, AND SAW BACK DISTRICTS.

The Detroit mining district was organized in the fall of 1872 as Drum district, but was abandoned until reorganized under the name of the Detroit in the spring of 1879. There are large copper veins in limestone and granite, the ore containing a few dollars per ton in silver and copper. The claims are the Howard, Gray Eagle, and Mammoth. The first mentioned had several hundred feet of cuttings and had from five to ten men employed during the census year. The camp is 30 miles northwest of Deseret station.

The Sevier Lake and Saw Back districts, in the range west of Sevier lake, were organized in 1872. They contained few locations and had been practically abandoned.

PI UTE COUNTY.

OHIO DISTRICT.

The Ohio mining district is a few miles square and includes several precipitous ridges and deep gorges on the eastern face of the Mount Baldy range, 90 miles south of Juab. It was organized in 1868 or 1869, and reorganized in August, 1872. There were one hundred and thirty locations on the records, but not a quarter of that number are still owned. Marysvale, 6 miles from the mines, in the valley of the Sevier river, is the district post-office and the settlement from which supplies are obtained. The veins are mostly bedded veins lying almost horizontally between strata of limestone and quartzite; but some fissure veins in granite or porphyry are found. In general, they are of medium size and grade, and undeveloped. About twenty-five men were prospecting in the district in the census year. Water is abundant and agricultural products are cheap. The altitude of the claims varies from 6,500 to 8,500 feet. In 1872 a 2 stamp mill was erected by the Pi Ute company, but owing to the inexperience of the managers it was a complete failure. Its machinery has long since been scattered over the country, and the district is without reduction works.

The following are the principal mines of the Ohio district:

Mines.	Total length of openings.	Condition at the close of the census year.	Remarks.
	Feet.		
Copper Belt	280	Active	Ore assays $200 gold and about 200 ounces silver; 20 tons shipped prior to June, 1880; much since.
Webster and Homestead	a 200	Idle	Ore assays $12 gold and $58 silver, average.
Great Western	b 150	....do	Ore assays $20 to $150 per ton.
Morning Star Group	300		Ore high-grade mill; few tons shipped in census year sold at $120 per ton.
Beecher	500		Ore averages $25 per ton.

a Shafts; also cross-cuts, etc. b Shaft.

The Chattanooga, Belle of the Vale, Mohawk, Belle of Monroe, Fillmore, Silver King, and others are for the most part "blanket" veins, between limestone and quartzite, containing from 6 inches to 2 feet of smelting ore, assaying $40 on the average. These had from 100 to 250 feet of cuttings, but had never shipped any ore.

Cinnabar float has been discovered in this district, but no veins have ever been found.

MOUNT BALDY DISTRICT.

[August, 1880.]

The Mount Baldy district adjoins the Ohio district on the north, and extends along the precipitous eastern face of the same mountain range for 8 miles. The general features of the country, topographical and geological, are the same as those of the Ohio district. It was organized September 18, 1878, and the records show one hundred and ninety locations. Aside from the ore of the Deer Trail and Pluto, no ore has been shipped, only a small amount of prospecting having been done. Wood and water are very abundant, and on the whole the district is a very promising one. On the bench at the base of the range and above the river bottom lands, there are extensive banks of drift gravel and bowlders, which, it is said, will give the color of gold anywhere. A little was washed out by Mormons as early as 1862. It probably would not pay to hydraulic it at present.

The Deer Trail mine is situated on a very steep mountain side, 1,500 feet above the Sevier River valley, 5 miles southwest of Marysvale. It was discovered in September, 1878, by a piece of float ore found on a deer's trail, and was the first location in the district. It was worked steadily until July, 1880, when it was bonded. It has been idle most of the time since. The property consists of the Deer Trail, Green-eyed Monster, and Cliff claims on the same vein; the Pi Ute and Red Pine claims on a parallel vein on the bluff 1,000 feet above; two 5-acre mill sites and a saw-mill site. The vein is both a contact and a bedded vein, between a limestone hanging and a quartzite foot wall, dipping southwest from 7° to 20°. The dip increases with the distance from the face of the mountain. The vein is continuous for a distance of 4,500 feet. One body of first-class ore, from 1 foot to 4½ feet thick, outcropped at the surface. Its shape is that of an equilateral oblique-angled parallelogram, 120 feet on a side, having one corner cut off. In the center of this there is a barren triangular space 75 feet long and 50 feet wide at one end. The ore is a soft, friable, greenish-yellow ocher, containing the products from the oxidation of lead, iron, and copper sulphides. It assays about $8 gold, $150 silver, and 35 per cent. lead. The second-class ore is a hard quartz, assaying about $2 gold and $48 silver, and is still on the dump. The mine is opened by five tunnels, which explore the ground only 120 feet horizontally. The total openings are about 1,200 feet. The exact product cannot be stated, but was a few hundred tons. The cost of shipment to Salt Lake City is $21 per ton.

The Green-eyed Monster is the northern extension of the Deer Trail. In this claim the vein suddenly enlarges and the ore is of lower grade. The dimensions of this body, as far as known from the large amount of prospecting done, are: Thickness, 35 feet; length, 280 feet; and width, 160 feet. This body of ore is an iron-stained, seamy quartz, with clay and much talcose matter. From a large number of assays that have been made it is estimated that the entire mass would average from $20 to $25 per ton, one-third of the value being gold. There were about 2,500 tons of this ore on the dump, which had been taken out in prospecting; and it is estimated that there were 75,000 tons in sight in the mine. There is a fine water-power, but capital is needed to build a mill. In this ore body, as also in that in the Deer Trail, there are crevices from 1 inch to 10 inches wide, which furnish excellent ventilation to the mine. The sides of these crevices are frequently covered with an earthy oxide of manganese and beautiful crystals of wulfenite. The claim is developed by a 120-foot shaft and a 285-foot main working tunnel. The extreme extent of development is 330 feet north and south, and 280 feet east and west. The cuttings aggregate 1,850 feet. No ore has been shipped. During the census year about twenty-five men were employed at from $2 50 to $3 50 per day. On the ground claimed by this company there are several undeveloped bedded veins showing from 6 inches to 3 feet of an ocherous lead ore assaying $45 per ton.

The Pluto mine is on the mountain side above the Deer Trail. It was located in June, 1879. It is a 20-inch vein in limestone. The ore contains horn-silver in which particles of gold are visible. Seven tons of the sorted ore had been shipped and averaged about $100 gold and $200 silver per ton. It was only developed by a 40-foot incline and an open cut 6 feet wide and 240 feet long on the face of the bluff.

The Lucky Boy claim on the side of this mountain contains small bunches of selenide of mercury in limestone. This is a rare mineral.

Other promising prospects in the district are the Alma, Plata de Mina, Uncle Sam, Rothschild, Clyde, Crystal, and Monte del Rey.

COPPER.

Beds or "reefs" of copper ore, from 1 foot to 7 feet wide in calcareous sandstone, are reported in Rabbit valley, 80 miles east of Marysvale. Specimens assayed 35 per cent. copper, with no gold or silver.

ANTIMONY.

The writer was not able to visit the antimony mines. The following information, however, has been gathered from various sources, and is considered reliable. There are eleven locations, eight of which have yielded ore, on a flat bedded vein in calcareous sandstone and shale, near the summit of a table mountain or bench, on Coyote creek, 9 miles from Clover Flat, and 40 miles southeast of Marysvale. They were located in May, 1879, and work was begun in the following September. The vein or bed is 8 inches thick, and contains pure fibrous stibnite, somewhat

oxidized in places. This assays only about a dollar in silver. The first lots of ore were gathered from the surface of the great heaps of *débris*. The only work consists of a few tunnels from 10 to 20 feet long. About 100 tons have been shipped. It was said to sell in New York or San Francisco for $85 per ton. The cost of transportation to Salt Lake City is $26 per ton.

BEAVER COUNTY.

SAN FRANCISCO DISTRICT.

[August, 1880.]

The San Francisco district is situated in the center of Beaver county, about 225 miles south-southwest of Salt Lake City and 98 miles northeast of Pioche, Nevada. The district is about 7 miles square, and lies upon both flanks of a small range called the San Francisco mountains. It was organized August 12, 1871, but was of little importance until 1876, a year after the discovery of the Horn-Silver mine. Frisco, the town and post-office, has about 800 inhabitants, and is the terminus of the Utah Southern railroad extension.

The country rock of the range consists of crystalline dolomitic limestone on the south, granite in the center, and a light-red quartzite on the north. The entire eastern slope is overlaid by a volcanic rock, which has perhaps erroneously been called trachyte, a short distance above the level of the valley. Still farther east are extensive beds of tufa. The water in the district is very bad and scarce. Boilers with flues cannot be used, or at most but a few days, owing to the great quantity of scale formed. Drinking water is brought on the railroad from Black rock, from 30 to 40 miles distant, or hauled 10 miles from springs in the Wahwah range.

About seven hundred and forty locations had been made in the district, but not over two hundred were claimed at the time of the writer's visit, and not over thirty had $500 worth of work upon them. The principal mines of the district are the Horn-Silver and the Carbonate.

THE HORN-SILVER MINE.—This remarkable body of ore was discovered September 24, 1875, by James Ryan and Samuel Hawkes. They sank a short shaft 30 feet in the ore, which came within 10 feet of the surface, and, fearing that the ore would fail, sold for $25,000 to A. G. Campbell, Matthew Cullen, Dennis Ryan, and A. Byram, on February 17, 1876. These persons sold ore, erected smelting works, developed the ore body in the mine, and in 1879 sold the greater part of their interest at the rate of $5,000,000 for the whole property. The Horn-Silver Mining Company was incorporated under the laws of Utah on February 17, 1879. The capital stock is $10,000,000 in 400,000 shares. The property of the company consists of the Horn-Silver claim, 1,440 by 600 feet, patented; two 5-acre smelter sites in the town of Frisco, also patented; a complete three-stack smelting plant; refining works at Chicago, Illinois; some iron flux mines near Frisco; charcoal kilns; a 40-mile telegraph line to Beaver; two large stores in Frisco; and other minor property. Two very elaborate reports were made upon the property in March, 1879, one by W. A. Hooker, E. M., and one by Henry Cummins. The following are extracts embracing the principal portion of Mr. Hooker's report:

The vein is traceable for about 2 miles from the southeastern end of the Grampian mountain to the point where the dolomites give place to granite, with a general course of N. 10° W. Six locations have been made within these limits, but no extensive or valuable body of ore has as yet been found, except within the lines of the Horn-Silver claim, although comparatively little work has been done upon the others. In addition to these is a claim called the Grampian, adjoining the Horn-Silver on the west, an earlier location upon a vein in the lime rock, from which valuable ore has been taken.

The width of the vein on the Horn-Silver property is somewhat obscured at the surface. At the point of discovery, however, it has a width of from 40 to 60 feet, and croppings of galena were seen throughout the length of the claim and beyond. On the extensions north and south no considerable amount of ore has been discovered up to the present time, the few shafts and tunnels which have been driven disclosing principally oxides of iron. Float ore has, however, been found all along the surface, especially on the south extensions. The general course of the lode, as was said, is N. 10° W., but the limits of the ore in the few places where they have been reached in the workings of the mine do not always conform to this direction. The lode dips to the eastward (N. 80° E.) at an angle of about 70° from the horizontal, so far as can at present be determined. Its foot wall thus consists of layers of quartzites and dolomites, while the hanging wall is a partially decomposed [so-called] trachytic material. With these circumstances it would be anticipated that variations in the dip and direction of the wall would occur at various points; especialy is this true of the foot wall, the softer parts of which—the dolomites—are more readily decomposed and eroded than the quartzites, causing variations in its lines. The width of the lode is therefore found to vary at different points. The shortest distance that can be measured between walls in the present workings is 28 feet, but on the same level to the northward it widens shortly to upwards of 60 feet, and in the lowest level, the fifth, as will be seen, it is probably even greater. Both walls are covered with a dry ferruginous clay which serves to indicate the approach to the wall-rock. The foot wall has not been penetrated by any of the workings, but the hanging wall has been pierced for a distance of 200 feet or more by a drift connecting the third level with the new shaft. It discloses the following material: Adjoining the ore from 20 to 25 feet of clay, stained with oxide of iron, followed by 30 feet of tough blue clay which required the use of chisel-pointed picks in driving through it; this blue clay becomes gradually harder, finally merging into a decomposed trachytic mass which continues to the end of the drift. The new shaft is sunk throughout in this last material. Its color is a reddish-gray, and it disintegrates somewhat on exposure to the air. It contains rounded pebbles or fragments of trachyte in size from that of a nut to masses several feet in diameter. At one or two points in the drift hard unaltered trachytic rock was met, but such appeared to be rather fragments than rock in place. Undoubtedly, at a greater depth, the country rock will be reached compact and dense, separated from the ore by selvedge clay.

As to the lode itself, the ore filling this immense fissure is of two general kinds or classes. The larger portion, which is distinguished as smelting ore, is soft and earthy, consisting of sulphate, oxide, and carbonate of lead, all carrying silver. The smaller portion is heavy spar (sulphate of baryta) carrying chloride of silver, sulphide of silver, and ruby silver—the richest silver minerals. This sparry ore is

found on the side of the hanging wall in the upper part of the lode, and has been protected somewhat from the decomposition which has affected the remainder of the ore by its position and the refractory nature of the material. With this exception, and one other, which will be noted beyond, the entire deposit of ore within the present limits of the mine has undergone oxidation and rearrangement of its component parts.

It is a very noticeable fact that up to the present time no wall fragment, "horse," or waste rock of any extent has been encountered in the deposit of ore. The material filling the vein is silver-bearing from wall to wall. There is no waste dump at the surface, and none of the contents of the lode as yet broken down have been so poor in silver as to be thrown away or used for gobbing up. The mine is entirely dry, and likely to remain so for a considerable depth.

DESCRIPTION OF THE MINE.

The principal working shaft is near the center of the claim, at the discovery. It extends vertically 113 feet 6 inches to the bottom of the third level. The first level is at a distance from the mouth of the shaft of 46 feet. At 27 feet 8 inches below, or 73 feet 8 inches from the surface, is the second level, and 39 feet 10 inches below this, or 113 feet 6 inches from the surface, is the third level. The fourth level, 91 feet 3 inches below the third (or 204 feet 9 inches from the surface), is connected with it by three winzes. The fifth level is 50 feet 4 inches below the fourth, or 255 feet 1 inch from the mouth of the working shaft. The old shaft lies 145 feet to the northward of the working shaft. It was continued down to the line of the second level and connected with it by a drift. The length of the old shaft is 100 feet 7 inches, the surface being higher here than at the working shaft, and if the depth of the fifth level be measured through the former it will show a gain of 26 feet 11 inches, or a total depth of 282 feet.

The ore thus far removed has been taken from between the first and third levels (the lower levels having been driven merely to explore the vein), and the space thus left vacant has been timbered up securely by 12-inch timbers in square sets 5 feet by 5 feet 8 inches, center to center, and 6 feet 10 inches high, except the track floors, which are 7 feet 2 inches in height.

* * * * * * * *

The first level is 46 feet below the track at the surface. It is entirely in ore, no wall or indications of wall appearing. From the northern side a drift is run 42 feet, from which a short elbow extends 21 feet in length. On the southern side a crooked drift has also been driven 56 feet. This exposes for the most part sparry ore, which has its greatest development in the southeast portion of the mine. In this neighborhood the ore referred to is crystallized and compact, and when in this condition its limits are quite distinct. The length of the first level from end to end in a straight line is 122 feet.

The second level is 73 feet 8 inches from the track at surface. On the northern side is a drift 148 feet in length. This connects with the old shaft, and at the end of the drift a winze connects with the third level. Here is observed the ferruginous clay and other signs denoting probable proximity to the hanging wall. It is the only point on this level where any such indications are afforded. The southern end of the level likewise consists of a short drift, having a course of S. 40° E., 21 feet; near its entrance occurs crystallized sparry ore merging gradually towards the north into a partially decomposed mottled ore, carrying more or less lead with silver; the remainder of the material exposed in this level is smelting ore. The total length of the second level, from end to end, measured in a straight line, is 295 feet, or following the sinuosities of the drift, 325 feet.

The third level is 113 feet 6 inches from the surface at the working shaft. The shaft is lagged at the bottom as elsewhere, but the foot wall was undoubtedly reached by it; indeed it is probable that the foot wall is quite near to the timbering all along the western side of the level. This could not be absolutely determined, as the boundary is concealed by lagging. A drift in the northern end of the level has a length of 99 feet. The southern end connects by a winze with the second level. In the ends of both the main and side drifts are signs of proximity to the foot wall. As was remarked, the hanging wall is indicated at the top of the winze referred to on the second level. If these indications are correctly interpreted the vein would have a width here of from 35 to 38 feet, but I do not consider it as definitely settled that such are the limits of the ore body in this part of the mine. Excellent ore is exposed throughout in the above winze. The southern end of the third level consists of a drift 56 feet 6 inches in length. Near the beginning of it, on the western side, is apparently foot-wall clay, and in the end of the drift is a similar material, probably marking the approach to the hanging wall. This level is connected with the fourth by three winzes, numbered 1, 2, and 3. Near the latter commences the drift already described, connecting with the new shaft. Its course is S. 86° E., 190 feet, and S. 61° E., 24 feet. A commodious station is built here, 16 feet by 20 and 12 feet high. Between winzes No. 2 and No. 1 occurs the white mottled ore, which merges near winze No. 1 into sparry ore, continuing beyond for seven sets of timbers. The material in the north drift consists largely of mottled ore.

The total length of the third level in a straight line is 300 feet, or taking into account the irregularities in the drifts, 310 feet. These measurements have of course no reference to the drift connecting with the new shaft.

The fourth level is 204 feet 9 inches below the surface at the working shaft. Fourteen sets of timbers have been placed in the south end of the level, the rest consists of irregular galleries, all in ore. The sparry ore, before described, does not appear on this level, but we have in place of it, *i. e.*, occupying the same relative position on the east or hanging-wall side of the lode, an ore differing in several respects from any before mentioned. From the fact that a small amount of it—about 100 tons—was treated in the leaching works in Frisco, it has been designated at the mine as leaching ore. It carries a very fair amount of silver, and its characteristics will be described in detail beyond. The main drift of the fourth level has been driven on the boundary line between the smelting and the leaching ores. From the south end of the timbering a drift has been started in the direction of the new shaft, 40 feet 8 inches, which penetrates the hanging wall from 6 to 10 feet from its end. We have, at this point, the opportunity of measuring the exact width of the vein—one of the few places in the mine where this can be done. It has here a width of 45 feet horizontally. At this end of the level and adjoining the foot-wall clay the smelting ore has a thickness of only 6 feet in the narrowest point. It widens out, however, to the northward, and near winze No. 2 is some 25 feet thick—soft, pure, oxidized ore. The so-called leaching ore comprises perhaps half of that exposed in this level.

Between the north end of the level and winze No. 1, on the east side of the drift, is a considerable amount of sulphide of lead and antimony. This material has been preserved from the oxidation which the greater part of the ore contained in the mine has undergone. It carries about 60 per cent. of lead, from 6 to 10 per cent. of antimony, some iron, considerable zinc, and but little silver.

How extensive this deposit is cannot be determined without further exploration. Two or three pieces only of the mineral were observed in the upper workings, although it was carefully searched for, and these pieces no larger than the fist, and as it has not appeared on the fifth level it is to be hoped that it will be found to confine itself to small limits. It is interspersed with lead ores carrying considerable silver, as will be seen hereafter.

The length of the fourth level, in a straight line, is 220 feet, or, following the curves of the main gallery and southeast drift, 245 feet 6 inches. The fourth level is connected with the fifth by a winze, starting 42 feet 5 inches easterly from winze No. 2. It has a vertical depth of 50 feet 4 inches below the fourth level. It begins in leaching ore, but runs shortly into soft smelting ore, which continues down to within a short distance of the bottom.

The fifth level consists of a single drift which has been started in the direction of the new shaft, having a course of S. 75° E., and a length, at present writing, of 68 feet 10 inches. It does not run directly across the lode, but diagonally, yet it proves the vein to have a thickness here equal or greater to its widest extent above. The west end of the drift is in foot-wall clay, but it does not penetrate the hanging wall, and only reaches leaching ore some 10 feet from the end. Should this leaching ore have the same thickness here as on the level above, the width of the vein would be some 90 feet; whether it will attain such dimensions remains to be proved. The greater part of the drift discloses excellent smelting ore, which, near the bottom of the winze, merges into foot-wall clay.

The Horn-Silver ores are distinguished at the mine as milling ore, smelting ore, and leaching ore. The latter, however, is properly also a smelting ore, but as it has certain features different from the rest, the name, although not altogether a correct one, will be retained in this report.

The name milling ore has been applied to that portion of the ore consisting essentially of heavy spar carrying chloride of silver, sulphide of silver, and ruby silver. It includes both the sparry ore so frequently mentioned and that described as mottled ore, besides certain other varieties found adjoining or interspersed with these.

The term of milling ore has been adopted because, being for the most part free from lead, it is adapted to the milling process. It may, however, be smelted also, and is thus treated at Frisco. While the crystallized sparry ore consists wholly of sulphate of baryta, except of course the silver minerals contained in this gangue, the mottled ore contains more silica, and, as will be seen, the gangue of some varieties of the milling ore is made up principally of silica. The milling ores constitute the richest portions of the deposit, carrying from 75 to 200 ounces in silver per ton in quantity, while smaller samples run into the thousands.

The smelting ores proper comprise the greater portion of the ore mass. These are soft and earthy, consisting essentially of sulphate of lead, with some plumbic ocher and carbonate of lead, all carrying silver. They have no gangue rock or vein stone, unless the silica, oxide of iron, and alumina (forming a sort of clay) be reckoned as such. The amount of lead and silver contained in these ores varies somewhat between certain limits, the lead running from 30 to 60 per cent., and the silver from 30 to 75 ounces per ton. In order to determine the relative proportions of the different ingredients and impurities of this ore, a sample was submitted to Mr. S. B. Newberry, E. M., of the School of Mines, New York, for analysis, who reports as follows:

ANALYSIS OF HORN-SILVER ORE No. 1.

	Per cent.
Moisture	Undetermined.
Silica	15.17
Sulphate of barium	0.49
Sulphate of lead	74.51
Sesquioxide of iron	4.80
Sesquioxide of alumina	1.71
Sulphide of antimony	0.37
Sulphide of arsenic	1.12
Lime and magnesia	0.50
Carbonic acid	0.62
Silver (by fire assay 78.33 per ton =)	0.33
	99.62

"No zinc was found; the quantity is certainly very small and did not show itself, although a special determination was made to ascertain it. The metallic lead, arsenic, and antimony in the ore are as follows:"

	Per cent.
Lead	50.90
Arsenic	0.93
Antimony	0.26

The amount of moisture in the ore is very small, the average of the run-of-mine being less than 3.5 per cent., and the sample analyzed above had been thoroughly dried.

The so-called leaching ore has been referred to as occurring on the fourth and fifth levels. It is somewhat distinct from any of the ores previously described, and quite different in appearance. It is more or less hard and compact; red, white, and yellow in color. A partial analysis of a sample of this ore was also made by Mr. Newberry, showing its principal ingredients. The following are the results:

PARTIAL ANALYSIS OF HORN-SILVER ORE No. 2.

	Per cent.
Silica	47.95
Sulphate of barium	2.71
Sulphate of lead	28.80
Sesquioxide of alumina	12.55
	92.01

"In addition to these constituents the ore contains a little zinc, carbonic acid very little, more arsenic and antimony than ore No. 1, a trace only of lime, and a small but quite noticeable amount of magnesia."

While these are the main distinctions in the character of the Horn-Silver ores, the lines between them cannot always be drawn so closely. They vary greatly in different parts of the mine, sometimes in very short intervals, rich ores alternating quickly with leaner ones, and pure smelting ores with those containing no lead. That which has, for convenience, been designated as mottled ore often carries considerable lead, and is more properly a smelting than a milling ore; and much of the leaching ore contains less lead than is shown in the above analysis.

The ore coming from the mine has, with the exception of the sparry ore, a yellow color due to sulphate and oxide of lead, the more siliceous portions somewhat hard, but the bulk of the run-of-mine is quite soft. It is difficult to make an estimate of the relative amounts of the different kinds of ore found in the different workings, and impossible to give an exact one. The amount of pure crystallized heavy spar ore at present disclosed may be stated at about 2,000 tons; that described as mottled ore occupies much more space, and the so-called leaching ore comprises at least half of the ore disclosed on the fourth level.

The following figures were taken from the company's books:

LOTS (AVERAGING 400 TONS EACH) ASSAYED AT THE SMELTER FROM JANUARY 1 TO FEBRUARY 14, 1879.

Date.	Lot.	Description.	Silver per ton.	Lead.
			Ounces.	*Per cent.*
Jan. 2	No. 30	Milling ore	97.20	21.00
Jan. 21	No. 31	Lead ore	42.74	45.00
Jan. 22	No. 31	Milling ore	89.91	6.00
Feb. 4	No. 32	Lead ore	41.31	47.00
Feb. 4	No. 32	Milling ore	136.00	7.00
Feb. 14	No. 33	Lead ore	38.86	49.00
	Average of all ores		74.53	29.16
	Average of milling ores		107.73	11.33
	Average of smelting ores		41.31	47.00

The average of 1,271.585 tons reduced by the Frisco Smelting Company up to March 1, 1878, was: Silver, 44.56 ounces per ton; 41.11 per cent. lead.

The average amount contained in 5,611.864 tons reduced by the same company from March, 1878, to February 1, 1879, was: Silver, 44.48 ounces per ton; 40.83 per cent. lead.

The ore reduced in the company's smelting works from December 15, 1877, to January 1, 1879, comprising 8,696.546 tons, contained an average of: Silver, 49.86 ounces per ton. The average of the three lots last given, a total of 15,580 tons, is: Silver, 47.75 ounces; lead, 38.25 per cent.

The quantity of ore extracted up to February 1, 1879, is given as 22,712 tons. During February about 90 tons daily were raised, making a total of 25,000 tons of ore. The extraction of this 90 tons was barely enough to keep the mine in good shape and prevent the breasts of ore from crowding too much upon the timbers. The present expense of mining is low. We have as the cost of taking out 90 tons daily:

Labor	$144 00
Timbering, 90 tons, at 82 cents per ton	73 80
Superintendence	6 00
Supplies and incidental expenses	50 00
Total	273 80
Cost per ton	3 05

The expense of mining the 22,712 tons up to February 1 was, of course, somewhat higher, amounting to $4 46 per ton. This expense included surveying and application for patent, mail service, the initiatory expenses of the enterprise; in short, all the expenditures of the mine up to that date.

Of the 25,000 tons mined about 5,500 tons have been sold to various parties; the remainder has been treated in Frisco by the Frisco Smelting Company and in the company's own works.

THE SMELTING WORKS.—The smelting plant of the company consists of three shaft furnaces with 40 horse-power engine and boilers, one No. 6 Root's blower, a Blake crusher, and other necessary appurtenances.

The furnaces are placed in line with four dust chambers between stacks, or eight in all (6 feet by 5 feet 9 inches by 6 feet 2 inches each). The furnaces are circular, the hearths being built of a fire-stone of excellent quality (*volcanic tufa*) found in the immediate vicinity. Two of the furnaces have the following principal dimensions, the third being somewhat smaller:

Tuyere line to charging door	12 feet 4 inches.
Diameter of hearth	38 inches.
Diameter of bosh	60 inches.
Diameter at throat	53 inches.

The furnaces are provided each with five water tuyeres, 3-inch nozzle. The hearth below the tuyeres is protected by cast-iron plates arranged hexagonally. The stack is built of fire-brick and common brick, supported by cast-iron pillars. The average campaign is sixty days. A single furnace only has been run at a time owing to the scarcity of water. The smelting of the ore is preceded by a calcination or roasting in heaps with wood, and, although it is far from being a complete roasting, it nevertheless puts the ore in good shape for charging into the furnace, and has the great advantage of economy. The fuel used for smelting is an inferior quality of charcoal. The principal flux used is iron oxide from various mines in the neighborhood, and at present about one-sixth of the ore smelted consists of milling ore. The product is from 6 to 9 tons of lead bullion per stack per diem, carrying an average of 150 ounces silver to the ton. About 1½ tons of matte are also produced daily, which, after a partial roasting, is charged back into the furnace. From 1,200 to 1,500 pounds of flue-dust are saved daily. The following is the work for January, 1879:

Amount of ore smelted	tons..	723.1125
Bullion produced	do..	202.1507
Ratio of ore to bullion		3.56
Iron ore used	tons..	329.425
Or 50.78 per cent of the ore.		
Amount of charcoal used	bushels..	33,286
Or 46 bushels per ton of ore.		
Wood for roasting and fuel	cords..	239
Or three-tenths of a cord per ton of ore.		
Wear and tear per ton of ore		$1 72
Pay-roll per ton of ore		4 75
Total cost per ton of ore		18 31
Cost per ton of bullion produced		65 05

THE REFINING WORKS.—The refining works are located in Chicago, at the junction of Lumber and West Twelfth streets. They have a capacity of about 15 tons daily. The plant consists of:

Two zinc-mixing furnaces, one 6 feet 8 inches by 10 feet, and the other 4 feet 6 inches by 6 feet.
One lead-refining furnace 6 feet 6 inches by 9 feet.
Four retort furnaces (Faber du Faur).
One small cupola furnace for reducing dross, etc.
Two cupel furnaces.
One small sweating furnace.
A 5 horse-power engine and boiler.
A Sturtevant blower, No. 4.
Assay office, etc.
The fuel used is Laurel Hill coal.

The works are under the control of Mr. A. Byram, and Mr. R. S. Payne is superintendent, and while the capacity of the plant is inadequate to the requirements, the work accomplished is excellent, and reflects credit on the judicious management of these gentlemen, as the following figures show. The refined lead produced runs from clear to 4-10 ounce, and is generally altogether clear. The silver bullion runs from 990 to 995 fine, and is said to be the purest bullion received at the New York assay office.

The loss in zinc is less than 33 per cent.; the loss in lead amounts to 7.52 per cent, and the loss in silver 1.65 per cent., or about 2¼ ounces per ton of bullion treated.

The following is the expense of treatment:

Coal	$3 28
Zinc	1 01
Labor	5 10
Incidental	1 90
Total expenses of refining per ton of bullion	11 29

The refined lead sold in January for $72 per ton.

Between the time of this report and that of the writer's visit, in August, 1880, but few changes had taken place. Mr. Hill had just been appointed manager, and many changes were expected. The explorations had not been extended further. A large amount of ore had been extracted and the number of square sets necessarily increased. A three-compartment vertical shaft, 200 feet east of the croppings, had been sunk 200 feet and cross-cuts run to the ore body. The total cuttings, not including stopes, then amounted to 1,900 feet. Fine hoisting works, equal to any in the territory, were nearly completed. They consisted of two horizontal engines of about 70-horse power. They were coupled by a clutch, or worked independently. The two boilers were of 60 horse-power, and of the Babcock & Wilcox pattern. Sheaves 40 feet high, a flat steel-wire cable, 8½ inches by ½ inch in section, cages, and safeties were used. The machinery was supposed to be capable of sinking 1,200 feet. A great cave into some of the stopes below had occurred, leaving a crater-like opening on the surface 40 by 70 by 25 feet. The force employed during the census year was about forty miners (10-hour shifts), at $3 50, and fifteen other workmen. It was the intention to extract the ore in the future by contract at so much per car-load. The amount raised during the year was 16,053¾ tons. The total product of the mine to the end of the census year was given at 29,380 tons. Its average product or value was unknown; but a rough estimate placed the assay value at 45 ounces silver and 35 per cent. lead.

THE SMELTER.—Besides Mr. Hooker's description of the furnaces, there are a few items which may be mentioned. Before smelting, the ore is roasted in heaps of varying size, about 30 feet wide and 140 feet long being an average. Cedar cord-wood is piled 4 feet high, 20 inches of ore is spread upon it, another layer of wood 1 foot, and a final 1 foot of ore. This requires two or three weeks to burn. One cord of wood for 3 tons of ore is used. Wood costs $2 50 per cord. As the ore which comes from the mine is already oxidized, it is difficult to see how this roasting effects it, except to volatilize some arsenic and antimony and to burn off some sulphur still unoxidized. In proof of this, the furnaces still continued to form large quantities of matte, as when treating unroasted ore. In further proof, also, the following partial analyses, made in the company's laboratory, indicate the same result. They are averages of several analyses made. The samples were not necessarily from the same lots of ore:

	Raw smelting ore.	Calcined or roasted ore.
	Per cent.	*Per cent.*
Lead	39.2	36.7
Sulphur	7.8	6.7
Sesquioxide of iron	5.5	26.0
Silica	24.2	19.8
Baryta	8.0	.....
Sulphate of barium	.....	7.6
Lime	1.5	5.3
Alumina	6.1	10.7
Arsenic and antimony	5.1	.....

Two of the furnaces are lined with a tufa found in the district. The lining is 16 inches thick, and extends 3 feet high. It usually lasts thirty to forty days. A new lining costs $130. The third furnace is a cast-iron water-jacket, vertical for 15 inches, and having a batter at the bosbes of 6 inches per side in the remaining 13 inches. These furnaces run with a closed front. A varying quantity of limestone and iron flux is used. The limestone is quite pure, and costs $2 50 per ton. The iron flux is a limonite and hematite averaging from 55 to 64 per cent. iron. It comes from the Wahwah range, Iron Springs, Star, Beaver Lake, and San Francisco districts, and costs about $8 per ton. The charcoal used is about 25 per cent. of the smelting charge. It is an inferior quality compared with that used in the northern part of the territory, and costs 18 cents per bushel for kiln and 16 cents for pit coal. Heretofore no flue-dust has been saved. The lead and iron matte, which was quite abundant, is roasted in heaps and resmelted. It is said that there is considerable difference in the silver and lead contents of the mattes from the stone and water-jacket furnaces. No regular assays have been made, but the average of a few showed results in favor of the water-jacket of 24 ounces silver and 7.5 per cent. lead. Whether the charge in each furnace was exactly the same or not is unknown. The furnace lead was quite hard, and contained several per cent. of antimony. Since the completion of the railroad cost of shipping to Chicago has been reduced to $33 50 per ton. Some partial analyses of slag made at the company's office are as follows:

	1878.	March 28, 1880.	May 2, 1880.
	Per cent.	*Per cent.*	*Per cent.*
Silica	32.3	35.1	29.3
Oxide of iron	46.9	44.1	45.6
Alumina	5.0	11.7	12.2
Lime	7.0	4.2	10.4
Lead	8.6	0.5	(?)

During the census year 10,573¾ tons of ore were smelted, producing 2,886¾ tons of bullion. Besides this about 4,000 tons of ore were sold to the Frisco company.

Owing to the high price of labor, lack of water, poor quality, and constantly increasing price of charcoal, the company intended to shut down these furnaces and erect others at South Cottonwood. During the time of the writer's visit one furnace was being run in accordance with a new smelting theory of one of the superintendents. The experience of three years had proved that a large percentage of iron was necessary to flux the Horn-Silver ores. It was required as a base to unite with the silicic acid, and also as a base to prevent the formation of rich lead matte by forming a poorer iron matte. The new theory grew out of the desire to use less iron flux. It may be briefly stated as follows: "Smelting by chemical affinities is all wrong; the true theory is to melt the material and let the elements separate by specific gravity." In accordance with this theory very little iron flux was added to the charge. As a result, a very large proportion of rich lead matte was formed. The furnace lead, however, was so lumpy and contaminated with partially desulphurized galena that about half of it had to be returned to the furnace in the following charges. The exact percentage of loss during the run, as compared with the other furnace running on the "chemical affinity" plan, could not be ascertained; but the "specific gravity" theory was not adopted. It is but just to the local manager and the superintendent of the smelters to say that they were opposed to such experiments; but the indorsement of the theory by some of the principal eastern owners or officers overcame the opposition.

A "draft furnace" to work Horn-Silver ore was built in 1877 by a private company. It was built like an ordinary furnace, but had a flue extending up the side hill several hundred feet. It was hoped that this would create sufficient draft to dispense with an engine and blower. A few tons of bullion was made, but the draft could not be regulated. The fire would approach the surface of the charge and the bottom would "freeze".

A small leaching plant erected by a private company was completed in the spring of 1878. Some Horn-Silver ore was worked raw, and from 40 to 80 per cent. obtained. A roasting furnace was erected, and the works then did much better. The tailings were reworked, yielding 82 per cent. The leaching works were not altogether successful and were shut down after a few months, having treated less than 150 tons.

The Grampian is a prospect in the dolomite on the hill above and beyond the Horn-Silver. In March, 1880, it was sold to a Chicago company, the Grampian Silver Mining Company, for a round sum, and a considerable force of men have been prospecting since. A vein of ocherous lead ore assaying about $50 silver and some gold was found near the surface, and followed down 80 feet, showing from 1 foot to 8 feet of ore. It then contracted, as is frequent with ore bodies in limestone, and in subsequent prospecting had not widened again. Little stoping had been done. The mine is developed by a tunnel and an incline having a windlass. The total cuttings amounted to 515 feet. Less than 200 tons have been shipped.

The Frisco Mining and Smelting Company was incorporated in September, 1879, and is a reorganization of the Frisco Smelting Company. It has a capital stock of $2,000,000 in 80,000 shares. The company's property consists of one smelting plant in Frisco, the Carbonate group of mines in San Francisco district, stone quarry, wood ranches, charcoal kilns, furnace site, barns, wagons, and animals in the same district, the Cave mine and its group in Bradshaw

district, and an iron flux mine in Rocky district. The smelting furnace was built in the summer of 1877. It is situated in the town of Frisco and has usually run as a custom furnace, or bought ore from the Horn-Silver. The plant is a complete one and consists of a Blake rock-breaker, a No. 5 Baker blower, two horizontal boilers, one 40 horse-power horizontal engine, several pumps, a shaft furnace and flue-dust chamber, a reverberatory flue-dust slagging furnace, 10 by 36 feet, and five charcoal kilns adjacent to the works. The Horn-Silver ore which the company smelted was roasted in heaps in the same manner as by the Horn-Silver Company. The company worked the ore for $20 per ton, guaranteeing 80 per cent. of the silver and lead contents. The ore was smelted with an iron flux from the Cave and other iron mines, and required about 30 per cent. flux and 46 bushels of charcoal per ton. About 5 per cent. of flue-dust was caught, assaying 35 per cent. lead and 30 ounces silver. The matte, of which from 5 to 10 per cent. was formed, assayed about 20 per cent. lead and 30 ounces silver. It was roasted in heaps and resmelted. The slag assayed about 1¼ ounces silver and 2½ per cent. lead. The furnace force consists of eighteen men on 8- to 12-hour shifts, receiving from $3 to $4.

The Carbonate mine is situated on nearly level ground on the eastern side of the San Francisco mountains, 2½ miles northeast of Frisco. It was discovered in the autumn of 1878. Campbell, Burke & Donaldson bought it in February, 1879, for $10,000, sunk a shaft to the depth of 212 feet, and sold the property to the Frisco Mining and Smelting Company in September, 1879, for $100,000. The group of flanking and overlapping locations consisted of seven claims, 1,500 by 600 feet each, viz, the Carbonate, Ingomar, Rattler, Stepmother, Homestake, North Side, and South Side. Some showed ore, but little had been done on any except the Carbonate. This was discovered by trenches dug on the surface of the ground in the search for the source of rich float. It is apparently a fissure vein in so-called trachyte, but the hanging wall has never been found, no cross-cuts having been run. The gangue upon this side is a soft "trachyte" and talcose clay, which swells in the mine and slacks to a powder when brought to the surface. The vein dips 45° for the first 75 feet; below that its dip is 85° N., having a smooth, hard, regular foot wall. The ore is next the foot wall, and averages about 6 feet in width, although much greater and much smaller dimensions have been found. It is a conglomerate, composed of pebbles of trachyte from 1 to 6 inches in diameter, and an occasional one of quartzite, cemented together by talcose clay and argentiferous galena. This ore, except the quartzite pebbles, slacks readily to the size of fine gravel when brought to the surface. It was impossible to learn the average grade of the ore. One hundred and forty tons were smelted by the company, but the value was not given. About 700 tons of low-grade ore were raised during the census year and are now upon the dump. From various assays, the average value of the ore was estimated to be from 30 to 45 ounces silver and from 15 to 25 per cent. lead. The mine is opened by a single-compartment vertical shaft, 5 feet 10 inches by 4 feet 10 inches, to a depth of 330 feet. The shaft was sunk 40 feet north of the croppings. At 80 feet a little water was found (at the period under review 50 gallons per hour was hoisted with a bucket), and the ore changed from carbonate to galena. Drifts had been run every 100 feet, but the extreme limit of horizontal development was 225 feet. The total cuttings amounted to 1,315 feet. Every drift was timbered with 8- by 10-inch or 10- by 10-inch posts and caps, and 2- to 3-inch plank. It was found necessary to ease them once each month. No stoping had been done. All work had been to prospect the mine. There were small steam hoisting-works, containing a 12 horse-power engine, supposed to be capable of sinking the shaft 500 feet. About twenty men had been regularly employed. Owing to the low grade of the ore, no attempt was intended to be made to smelt it until after concentration. At the time of the writer's visit the company was erecting a 30- by 96-foot building in which to concentrate the ore, by means of Paddock's pneumatic separators. These were a new invention. They had been tested for several months on copper and lead sulphurets in Maine, and had also worked several tons of this ore at the Butterfield Cañon concentrating works, in West Mountain district, and had given satisfaction. The machinery to be employed was to consist of one rotary drier, one rock-breaker, three sets of Cornish rolls, six elevators, five revolving screens, having a 35 to 110 mesh, ten Paddock's separators, and one Frue concentrator. It was thought this apparatus would concentrate 50 tons in twenty-four hours.

The other mines of the San Francisco district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Makaiela and Summit	850	1,414 tons	Worked irregularly	1,314 tons assayed 75 ounces silver and 55 per cent. lead, and the other 100 tons one-third of this.
Cerro Gordo and Minnesota Consolidated Silver Mining Company.	800		A small force prospecting.	Ore assays $40 to $50 per ton.
Frisco Consolidated Silver Mining Company.	1,000	100 tons	Some prospecting done	Ore sometimes assayed as high as $200 per ton.
Chicago and Frisco Consolidated Silver Mining Company.			do	Property consists of twelve locations, having a limited amount of development.
Yellow Jacket	250	10 tons		High-grade ore.

COPPER.—In the northern part of the San Francisco district there are several very large ledges of pyrite and chalcopyrite ore. Some work was done upon them, and a small amount of very high grade silver ore was mined several years ago. The principal claims are the Comet, Cactus, and Copper Chief.

MARBLE.—Fine marble quarries have been located in this district; but little work, however, has been done on them. The marble is light-bluish to milk-white in color, takes a good polish, and can be obtained in slabs 8 inches thick.

FIRE-ROCK.—There are several fire-stone quarries, all within 2½ miles of Frisco. The stone is found in beds a few hundred feet in thickness. It is a very porous yellowish-white volcanic tufa. It is very soft, and is easily turned into shape when fresh from the quarry, but hardens on exposure to the air. It is of local importance only, owing to the siliceous character of the Horn-Silver ores and the cost of transportation of imported material. It is not comparable with the siliceous rock found near Salt Lake City.

CHARCOAL BURNING.—Thirty-six bee-hive charcoal kilns (*a*) supply the furnaces of the district with fuel. They were in eight groups, under separate individual management, at places where wood was accessible, and at distances of from 6 to 18 miles from Frisco. Some pit coal is burned in the Wahwah mountains, but it is sold for 1 or 2 cents per bushel less than the kiln coal, as the latter is cleaner and of better quality. The kilns are made of granite float found in the neighborhood and a lime mortar. They are of various sizes, from 16 to 26 feet in diameter. It is the rule in this section to make the height of the kiln equal to the diameter. The thickness varies from 18 to 30 inches at the base and from 12 to 18 inches at the summit. There are two openings, closed by sheet iron doors, one at the ground level, 4 by 6 feet, and the other in the side two-thirds of the distance to the apex, 3 by 4 feet. There are also three rows of vent holes, 3 by 4 inches, near the ground. The lower row is at the surface of the ground. The rows above are 18 inches apart, having vent holes 3 feet apart in each row. The kilns cost from $500 to $1,000 each, and lasted a very long time if used regularly. The 16-foot kiln holds about 15 cords of wood and the 26-foot kiln 45 cords. Sometimes the wood is piled radially, but generally very closely in cord-wood fashion. The wood is all piñon pine, and is cut at all seasons by Mormons at $1 25 per cord. It is brought from 1 to 4 miles by sledges or wagons to kilns for from $1 50 to $2 50 per cord. The kilns are fired in the center at the bottom (though sometimes at the top), and the fire is drawn to the top by leaving a small unsealed space around the upper door. This is then closed entirely, and the fire is regulated by the vent holes. The duration of burning is from three to seven days, and of cooling from three to six days. Charring, which includes packing the wood in the kiln and drawing the coal, is usually done by contract, and costs from 2¾ to 3½ cents per bushel. About 50 bushels are produced per cord charred. The coal is bought by weight, 17 pounds making a bushel. It is shipped to the smelters in racks, at a cost of from 3 to 5½ cents per bushel for hauling, depending on the distance. The price received is 18 cents per bushel. Kiln hands are paid from $2 to $2 75. The labor required averages one man per kiln per twenty-four hours.

PINE GROVE, WASHINGTON, STERLING, AND PREUSS DISTRICTS.

[August, 1880.]

The Pine Grove district is situated on a well-wooded and watered range 40 miles west of the San Francisco district. It was organized in 1873, but no work was done until the reorganization in 1879. There were at the period under review about 20 locations. Little had been done except by the Pine Grove Consolidated Mining Company, which owns the Carrie, Lucille, Crystal Palace, and Pinafore claims. These are from 2- to 4-foot veins of fair-grade ore in quartzite, having inclines but 70 feet deep.

Washington district is southwest of Pine Grove. It was organized in 1879, and has but few locations.

Sterling district is an iron district in the Wahwah range west of Frisco. It was organized in February, 1880, and contained at the period under review about 25 locations.

The Preuss district is an old district, and was reorganized in August, 1880. It contained at the period under review 25 claims. Among the fair prospects having some development are the Good Hope, Champion, and Silver Hill.

THE STAR DISTRICTS.

[August, 1880.]

The original Star district, 12 miles square, situated on the Picacho range, a few miles southwest of Milford, was organized July 8, 1870. On November 11, 1871, the northern portion was reorganized as North Star district, and the two districts, called respectively North Star and South Star, have kept up their organizations since. In the South Star the books showed 1,046, and in the North Star 581 locations, but probably not over 350 were owned at the period under review. The country rock of these districts is granite along a portion of the eastern border, distinct strata of quartzite, underlaid by limestone and siliceous limestone, in the central portion, and "trachyte", a portion of the same flood seen in the San Francisco district, along the western side. In the central portion of the district

a It is said that this style of kiln was first made by J. C. Cameron, in Marquette county, Michigan, in 1868.

beds of gypsum are also found. The mines occur entirely in the limestone and quartzite, and are usually bedded veins and pipes of ore, dipping with the stratification from 40° to 70° east or southeast. The mines are at an altitude of from 5,000 to 6,000 feet above sea-level, in ridges a few hundred feet above the Beaver River bottom lands. Water is very scarce, and costs from 5 to 9 cents per gallon. For this reason the mines are worked mostly in the winter season, when there is about a foot of snow on the ridges. The prosperous days of the district were in 1872, 1873, 1874, and 1875. Then there were the thriving mining camps of Shauntie, Shenandoah City, Elephant City, and South Camp. Shauntie contained forty houses, but was destroyed by fire in the summer of 1876. Few have been rebuilt. The work in the district has been done for the most part by poor men upon their own claims. Hence there are a host of rudely-worked prospects, with very little development. During the census year forty men were working and prospecting in the two districts.

Most of the ore produced was treated at the Shauntie smelter. Two small stacks were built at the town of Shauntie in the summer of 1873. In the following spring these were torn down, and one stack of 20 tons' capacity was built. This was burned in June, 1875, was rebuilt in the following autumn, and was shut down in the summer of 1877. A short run was made in 1878. It had been idle since. The furnace is quite dilapidated. About 12,000 tons of ore were worked, which produced about 3,000 tons of bullion, containing $325,000 in silver and $10,000 in gold.

The Troy furnace, erected in 1875 on the Beaver River bottoms, 5 miles south of Milford, to smelt Mammoth mine ore, ran but a few months. It had been idle since, and was burned in June, 1880.

The Latey & Williams smelter is a single-stack custom smelter, and was erected at Milford, east of the districts, in the autumn of 1876. The owners had worked about 500 tons of Star ore, 1,500 tons from the Horn-Silver, and 400 tons from the Cave mines, which had produced about 770 tons of bullion. The smelter had been idle for over a year, but was started again August 17, 1880. The plant consists of a stone shaft furnace, a No. 4½ Baker blower, a horizontal boiler and engine, and a small flue-dust chamber.

The Milford 10-stamp mill is in a fair state of preservation. It is in the town of Milford, and was erected in the fall of 1873, at a cost of $45,000, by a Scotch and Canadian company, called the Harrington & Hickory Consolidated Mining Company, to work the ores of the old Hickory mine, which had been sold to it for about $100,000. The mill ran a few months on about 35-ounce ore in the winter of 1873–'74, and produced from $9,000 to $12,000 in base bullion. It was then idle until leased by the Cave company in August, 1876. This company ran about five months, and produced $19,000 in very fine bullion. The mill has been idle since. The watchman sued for his wages and took the property in 1878. The machinery consisted of a fine 60 horse-power engine, two horizontal boilers, a Dodge rock-crusher, ten 750-pound stamps, six small wooden pans, three iron settlers, and a retort. At the time of the writer's visit a sampling mill was being erected. It was to be completed and ready to receive consignments of ore in a few months.

MINES OF NORTH STAR DISTRICT.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Rebel	600	4,000 tons	Idle	Ore assays average 35 ounces silver and 65 per cent. lead.
Hickory	525	1,000 tons	Active	Ore, porous quartz, with stain of oxides of copper and iron.
Osceola	200	50 tons	Worked irregularly	Ore assays 40 ounces silver and 20 per cent. lead.

MINES OF THE EASTERN FOOT-HILLS OF STAR DISTRICT.

The Vulcan, an iron-flux mine, situated 6 miles southwest of Milford, was discovered in the spring of 1872, but serious work was not begun until April, 1879. It was regularly worked by the owners, and the product sold to the Horn-Silver Company for $8 per ton. The mine consists of large bodies of ocher on the hanging wall of a small contact vein between a dolomite hanging and a granite foot wall. There are several of these extremely irregular bodies from 1 foot to 15 feet wide, already prospected 75 feet horizontally and 125 feet on a dip of 60°. The ocher shows traces of gold, silver, and cerussite. Occasional bunches of 45-ounce ore are found. The total cuttings are 400 feet. About 900 tons of the flux had been shipped in the year; very little previously. The cost of transportation, which the mine paid, was $4 per ton.

The Vicksburg mine was discovered in 1872. It has been idle since 1877, except assessment work. It is an N. and S. vertical vein, from 5 to 10 feet wide, in limestone near granite. An ocherous ore, containing from 15 to 50 ounces of silver and from 15 to 50 per cent. lead, was encountered in a chimney dipping about 40° N. Several tons of pure granular sulphur were found in a layer from 2 to 20 inches thick beneath the richest portion of the ore. Crystals of gypsum also occurred with the ore. The mine is opened by a 220-foot incline and 150 feet of other cuttings. Probably 200 tons of all grades have been shipped. There are several thousand tons of a soft low-grade ocher upon the dumps and in sight in the mine.

The Golden Era is a nearly vertical N. and S. vein, from 16 inches to 5 feet wide, in limestone. One chimney, 9 feet wide and 20 feet long, dipping 40° N. in the vein, has been followed over 200 feet. The ore is an ocherous carbonate assaying as high as 55 ounces silver, 40 per cent. lead, and $5 gold. There is a 245-foot incline on the vein, also 100 feet of other cuttings. A whim is used for hoisting. Three men have been working during the year. The total product has been about 250 tons, principally an iron flux.

MINES OF WESTERN STAR DISTRICT.

Mines	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Burning Moscow Hill Group	2,500	500 tons 20-ounce ore	Idle	Ore: first class, 100 ounces; second class, 15 ounces.
Mammoth and Income	1,050	$60,000	Assessment work only	Ore assays 20 to 120 ounces (average, 50 ounces) silver and 55 per cent. lead.
Hoosier Boy and Savage	1,670	4,000 tons	Idle	Ore assays 15 to 50 ounces silver and 32 per cent. lead.
Flora and Wild Bill	350	300 tons	Worked by small force	Ore assays 20 to 25 ounces silver and 30 to 40 per cent. lead.

MINES OF SOUTH STAR DISTRICT.

The Wasco mine is at South Camp, 7½ miles southwest of Milford, on one of the spurs of the highest peak of the Picacho range. It was discovered in the fall of 1874. It was worked until March, 1875, was idle for a year and a half, and was worked again until June, 1879, since which time it has been idle. It consists of a single pipe of a soft, yellowish limonite and carbonate ore, bedded in limestone, and dipping from 35° to 40° NE. One chimney began at the surface and has been followed 833 feet, and still continues. There are two or three contracted places or slight faults in it, and it varies in size from 1 foot to 10 feet thick, and from 10 to 30 feet wide, but is continuous. A tunnel 180 feet long cuts the pipe 300 feet from the surface, and is used to lessen the windlass work. The ore, when sorted, contains from 30 to 40 ounces silver, from $4 to $10 gold, and 40 per cent. lead. The assay value of the total product is estimated at 40,000 ounces silver and $5,000 gold.

The Harrisburg Hill Mining Company was incorporated in April, 1880, and was a consolidation of the interests of the mine owners on the hill to develop their property. The mining property is at South Camp, near the Wasco, and embraces eleven overlapping locations, which cover an area of about three full claims. They are all in a dolomite or limestone country rock, and, with the exception of the Harrisburg and Mountaineer, have but limited developments. The ore is a low grade ochery carbonate, which, when sorted, will assay from 25 to 150 ounces silver, from $3 to $5 gold, and 30 per cent. lead. It occurs in chimneys, pipes the size of a barrel, and irregular deposits.

The entire hill is seamed with small veins containing ocher. The principal work has been done on one chimney in the Harrisburg claim, in a bedded vein dipping from 40° to 65° E. A very irregular incline follows this chimney 225 feet on the dip, and explores it horizontally 75 feet. The ore is found in irregular deposits from 6 to 20 inches wide. The first-class ore, when sorted, assays $100 silver, 60 per cent. lead, and $4 gold. In the vein, on either side of the ore-body, is a band of fibrous gypsum from half an inch to 3 feet thick. Sometimes layers of mud alternate with the gypsum. In the lower works from 1 foot to 3 feet of "black spar", a calcareous rock containing a large percentage of oxide of manganese, is found. In general the country is much broken in the vicinity of this vein, one horizontal fault of 20 feet being found 90 feet from the surface. The total product of the mines of the group is estimated at 700 tons, averaging 50 ounces silver and 50 per cent. lead. There is much low-grade ore upon the dumps.

The other mines of South Star district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Elephant	650	75,000 ounces silver	Idle	Ore assays 40 to 80 ounces silver (av. 55 ounces), and 50 per cent. lead.
Croesus	400	30 tons, of 300 ounces silver.		
Saint Mary's	1,000	1,000 tons 10 ounces flux; 50 tons 80 ounces ore.	Worked regularly by a small force.	Has produced a large amount of iron flux for the Shaunlie and Frisco smelters.
Monitor	600	300 tons		Ore averages 30 ounces silver and 30 per cent. lead.
Garden City Silver Mining Company.				A consolidation of claims; most of them have from 100 to 300 feet of cuttings.
South Silver Mining Company.		100 tons		A consolidation of 7 claims; two have considerable development.

In addition to the above-mentioned mines of the Star districts there are very many claims with less development which have shipped from 10 to 80 tons.

As can be seen from the preceding pages, there have been many large bodies of rich ore found; but there are treble the number of medium-size bodies of low-grade ore that have only been shown and not developed on account of the great cost of transportation and the lack of concentrating apparatus. Ore of lower grade than 20 ounces will not pay to mine unless it can be sold for flux. The ore is a soft ocher, and doubtless would concentrate finely. Owing to the scarcity of water in the district the same character of ore will in all probability continue many hundred feet in depth; this seems therefore to be an excellent field for some kind of pneumatic concentrating machinery.

ROCKY DISTRICT.

[August, 1880.]

Rocky district is about 1½ by 3 miles in extent, and includes a small isolated range north of the Star district and east of the San Francisco. It was organized in 1872 and had, at the period under review, about 25 locations, although six times that number have probably been made. The country rock is granite, quartzite, and limestone. The principal work has been done upon the following claims:

Big Mountain tunnel.—On the side of a mountain there is an E. and W. vein 10 feet wide in granite. From a 100-foot shaft about 31 tons of assorted ore were shipped to Salt Lake City, which, it is said, averaged 30 per cent. copper, 25 ounces silver, and $12 gold. A tunnel to cut this vein at a depth of 400 feet was begun in June, 1878. The five owners have worked irregularly since then. The tunnel is a fine straight one 7 by 4½ feet and 573 feet long. Another 150 feet, it is thought, will reach the vein.

June iron mine.—This mine had shipped 1,500 or more tons of flux to Frisco in the previous few years.

Rocky iron mine.—This claim was owned by the Frisco Mining and Smelting Company, and is said to have shipped 2,000 tons of flux since its discovery. It is worked through great open cuts upon the surface.

Copper mine.—This is an immense vein of copper ore with croppings 100 feet wide. The ore is a carbonate stain in the joints of a siliceous rock, and taken together is of very low grade; but 30 per cent. copper ore, assaying $12 silver and $10 gold, can be sorted from it. Some has been shipped. There is to all appearances a 50-foot vein of an impure magnetic ore one side of this vein of copper. Shafts 75 and 55 feet deep have been sunk.

BEAVER LAKE DISTRICT.

[August, 1880.]

The Beaver Lake district is situated north of the Star and Rocky districts, and was organized in August, 1871, upon the discovery of a belt of copper veins from an inch to 2 feet in width. Some work was done in 1872 and 1873, and a few tons of ore were shipped assaying 30 per cent. copper, 16 ounces silver, and $12 gold. These copper veins have been idle since. In September, 1872, lead and silver ores were discovered. The leading mine is the San Francisco, which was sold for $10,000. About $8,000 worth of high-grade silver-lead ore has been extracted from a 110-foot shaft. It has been idle since 1873. The Dexter and Mountain King are iron mines, and shipped 400 tons of flux each between 1873 and 1877. A small vein containing graphite (or molybdenite) was also discovered. Little work has been done in the district in the last few years. The Riverside smelter was erected in 1873 at a point 7 miles north of Milford to work the copper ores of this district. It produced a few tons of copper matte and also a few tons of lead bullion in the few months that it ran. It has long been abandoned.

BRADSHAW DISTRICT.

[August, 1880.]

The Bradshaw mining district is southeast of Milford on the southern end of the Granite range. It was organized April 24, 1875, and contained at the time of the writer's visit about 100 locations. The country rock is mainly limestone, and the ore an ocher containing carbonate of lead and considerable gold.

The Cave mine, the principal mine of the district, is about 8 miles southeast of Milford and northwest of Minersville on a steep mountain side, about 4,300 feet above the Beaver river, and over 6,000 feet above sea-level. The cave in which the mineral was first found was discovered in 1859. The discoverer, a Mormon, is said to have dreamed for three successive nights of great wealth in that locality. It was not located, however, until 1871. Little was done until 1875 and 1876, when some ore was worked at the Milford mill. The mine became financially involved, and was mortgaged for $8,000. The mortgage was foreclosed in April, 1878, and in September, 1879, the mine became the property of the Frisco Mining and Smelting Company. The property has been worked continuously since April, 1878. The ore occurs entirely on the bottoms of caves in limestone or dolomite. Five large caves and fifteen smaller ones had been found. They are all connected by seams of ocher, or by holes which serve as run-ways for mountain rats. Beyond the caves already known there are doubtless others, as holes and other seams lead outward. The largest cave is 120 feet long, 30 feet wide, and 20 feet high, extreme dimensions. One of average size is not over 12 feet in extent. All have an extremely irregular outline. The roofs of some are covered with a thin coating of copper carbonate and silicate. There is usually a vacant space from 1 foot to 10 feet

between the roof and the ore. On the ore is usually a mass from 1 foot to 3 feet thick of blocks of limestone, which have fallen from the roof. The upper portions of the deposits are generally softer, more earthy, and less valuable than the lower, where the carbonate of lead occurs. In some places the fine ocher changes into a hard massive limonite, with cavities having botryoidal and stalactitic surfaces. In spots pure granular or crystallized sulphur is found, though not frequently. In places the ore has been very rich, assaying as high as $500 to $800 per ton. Ore of the lowest grade assays $5 in gold and silver. All the limonite and ocher, without regard to its grade, was shipped to the smelter at Frisco, it being worth from $8 to $10 for flux alone. The average grade of all the ore shipped could not be ascertained, but for several hundred tons recently shipped it was given at from 5 to 7 per cent. lead, $22 50 silver, and $7 50 gold per ton. The mine is perfectly dry, and the indications are that it will remain so for several hundred feet. The mine is opened by two tunnels, one 140 feet below the other. The lower or main working tunnel runs 300 feet in country rock before striking the cave deposits. There are only 1,400 feet of cuttings. The space partially explored and known to contain caves of ore is 300 feet long, 240 feet wide, and 150 feet deep. The method of working is to drive drifts and raises to the bottom of each cave. The ore is then stoped out overhead, the sides being timbered by square sets. The timbers are round, 1 foot in diameter and 5 feet long. Ore is dumped by mine cars into bins on the surface. These dumped into wagons, each drawn by ten mules, by which the ore is taken 23 miles to the Frisco smelter for $7 per ton. During the census year about 17 men were employed at $3 50 per day. The total assay value of the ore produced prior to June 1, 1880, is estimated at $270,000, one-quarter of which was gold.

The Jolly Boy is in the northern part of the district, and was discovered in the fall of 1879. The developments do not exceed 220 feet. Four tons of selected ore, a soft ocher, averaged $12 silver and $333 gold. The vein is said to be 1 foot wide in limestone, and to be faulted in the bottom of the shaft by a porphyry dike.

The Nip-and-Tuck, Reliable, Mountain Maid, and Promontory are prospects of value, but of limited development.

M'GARRY AND ANTELOPE DISTRICTS.

[August, 1880.]

The McGarry and Antelope districts are located on the western slope of the Granite range to the north of Bradshaw. They were organized in 1876 and 1877, and contain a few iron locations.

LINCOLN DISTRICT.

[August, 1880.]

Lincoln district is on the eastern slope of Granite range, northeast of Bradshaw district. It was organized January 16, 1871. About one hundred and seventy-five claims had been recorded, but not over thirty were worked at the period under review.

The principal claim in the district is the old Rawlings or Rollins mine. It is claimed by the Mormons that it is the oldest mine in the territory. They worked it in 1860, 1861, 1862, and 1863, and made a few tons of lead in a primitive way. The mine was sold in 1875 to the Lincoln Silver Mining Company. A 15-ton furnace was built in the fall of the same year. The company worked both the mine and the smelter for two years. The managers, however, were inexperienced in metallurgy; and this, in addition to the finding of a body of water which the pump was unable to raise, resulted in the works and mine being shut down. The incline was sunk 220 feet, and showed a 6-foot vein at the bottom. One-fourth of this was pyrites and the remainder galena. In the upper works the ore body was from 8 to 12 feet wide. The average assay of the ore was $40 silver and $15 gold. About 100 tons of bullion, worth $165 per ton, were produced.

The December group of mines had been recently sold to the December Mining Company of Chicago. The principal vein is from 1 foot to 4 feet wide, carrying a smelting ore which assays $100 per ton when selected. A few tons have been shipped. There are 200 feet of cuttings.

The Coral Reef, Yula, and Richmond are a group on one vein, said to be from 3 to 5 feet wide, containing a low-grade smelting ore, 20 ounces silver, 30 per cent. lead, and some zincblende and pyrite. The developments consist of 310 feet of cuttings. About 80 tons had been sold formerly. The mines were being prospected by fifteen men.

GRANITE AND NORTH GRANITE DISTRICTS.

[August, 1880.]

Granite and North Granite districts are situated northeast of Lincoln district and northwest of the town of Beaver. It is stated that they were organized in 1863 and 1865. The first mentioned has "thrown away the books and lost the recorder", but nevertheless contains a mine of considerable note in the neighborhood. This is the Bismuth mine. It was discovered about 1865, and has been owned by almost every energetic miner in the region, the principal work having been done about sunrise on January 1. It was, at the time of visit, known as the Major lode. The vein is from 5 to 7 feet wide, and contains a tough quartz or gangue. In this some pyrite, galena, and,

it is said, 3 per cent. of metallic bismuth are found. A few tons were shipped years ago which were said to have averaged from 7 to 10 per cent. bismuth. There is a 130-foot shaft, besides shorter ones and drifts, which aggregate 210 feet.

North Granite district has about 25 undeveloped prospects on narrow veins containing low-grade smelting ore.

IRON COUNTY.

IRON SPRINGS IRON MINING DISTRICT.

[July, 1880.]

The Iron Springs district is 8 miles west of Cedar City. In 1851 or 1852 the Mormons erected rude furnaces at Cedar City and attempted to reduce the ore. The attempt was a complete failure, and so work was discontinued in 1857. Old settlers said that it cost about $200,000 to produce 25 tons of iron. The district was organized in 1871 and reorganized in March, 1879. There were at the time of the writer's visit about 30 claims of 1,500 by 600 feet each, 14 of which showed immense croppings of magnetite and hematite. The mines are all within an area of 2½ miles wide and 5 miles long. Nothing has been done in the district except the assessment work necessary to hold the claims. During the census year several hundred tons of float were hauled to Frisco for flux. Near the mines is a fine spring.

PINTO IRON MINING DISTRICT.

[July, 1880.]

The Pinto iron district is a few miles southwest of the Iron Springs district and 20 miles west of Cedar City. The town consists of a few houses and the old furnaces, and is called Iron City. The district was organized in June, 1868. There were, at the period under review, 23 iron claims, 1,500 by 600 feet each, in an area 1 mile wide and 4 miles long, beginning 3 miles northeast of the town. These claims show immense croppings of hematite several hundred feet in length and breadth. The developments are merely nominal, only enough work being done to hold them and to entitle the owner to apply for a patent. The country rock in immediate contact with the hematite is sandstone, limestone, and granite. Piñon and cedar are moderately abundant on the adjacent hills.

In 1868 the Great Western Milling and Mining Company was organized by five Mormons. A rude furnace, a foundery, charcoal kilns, and the various necessary buildings for the manufacture of small cast-iron wares, were erected. It soon became a typical Mormon co-operative company. The church favored the enterprise and the settlers accepted stock for labor, material, and money advanced. In 1875 or 1876 the works were shut down, and the entire property was sold by the United States marshal. The company made only four runs, in all about nine months, and produced 400 tons of pig iron. This was made into castings, principally shoes and dies for the mills at Pioche, and was considered of excellent quality. The company expended about $100,000.

Professor J. S. Newberry visited these iron districts in the summer of 1880. The following is an extract from his article in the School of Mines Quarterly for November, 1880, on "The genesis of our iron ores":

> During the past summer, which I spent chiefly in Utah, I visited the deposit of crystalline iron ore of Iron county, in the southern part of the territory. These ore beds have been long known and were to some extent utilized by the Mormons in their first advent, thirty years ago, but no satisfactory description of them has ever been published. As they constitute, perhaps, the most remarkable deposit of iron ore yet discovered on this continent, I have thought that some facts in regard to them might not be an unimportant addition to what is known of the economic resources of our country. The iron region referred to lies nearly 300 miles directly south from Salt Lake City, and is situated in what is really the southern prolongation of the Wasatch mountains. The iron ores occur in the northern portion of a subordinate range, which attains its greatest height in Pine Valley mountain, near Silver Reef. Thirty miles north of this point the ridge breaks down into a series of hills from 1,000 to 2,000 feet in height, which consist chiefly of gray fine-grained granite, with dikes and masses of trachyte and here and there outcrops of highly metamorphosed limestone. The ore beds form a series of protruding crests and masses set over an area about 15 miles long in a northeast and southwest direction, and having a width of from 3 to 5 miles. Within this belt the iron outcrops are very numerous and striking; perhaps 100 distinct claims having already been located upon them, each one of which would make the fortune of a mining company if situated anywhere in the Mississippi valley or the eastern states. The most impressive outcrops are in the vicinity of Iron Springs, Oak Springs, and Iron City, of which localities the first and last mentioned are about 12 miles apart. Near Iron Springs the Big Blowout, as it is called, is a projecting mass of magnetic ore, which shows a length of perhaps 1,000 feet by a width of 500, and rises in castellated crags 100 feet or more above its base.
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> At Iron Springs a still more striking exhibition is made by the Blair mine, which is a ragged crest of magnetite, black as jet, formed by the upturned edge of the thickest of a series of sheets of ore, which rises like a ledge of bedded rock 200 or 300 feet above the adjacent lowlands. This outcrop is visible as a conspicuous black hill at a distance of several miles. The connections between the ore bodies of this great iron belt are obscured by the *débris* from the easily-decomposed trachyte and granite. It is evident, however, that for some miles the iron-ore deposits are continuous or separated by very short intervals, as the outcrops occur within a stone's throw of each other, and the surface is everywhere strewed with blocks of rich magnetic ore, enough in themselves to supply all the furnaces of the country for years. It would seem that the iron forms a number of distinct and closely approximated belts, which are the outcrops of beds that stand nearly vertical, and go down into the earth like huge walls.
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> There is considerable diversity in the character of the ore, though it is about equally divided in quantity between hematite and magnetite. Some of the beds of both are exceedingly dense and compact, while others, though rich in iron, are soft, and can be mined with the pick. Most of the ore is apparently very pure, containing a small amount of earthy matter and no foreign minerals. Some of the ledges, however, contain a large quantity of silica, the magnetite being mottled with white quartz; and one of the largest outcrops,

though showing many millions of tons of ore apparently quite pure, is thickly set along certain zones, evidently strata of deposition, with crystals of apatite from a quarter to half an inch in diameter and 2 or 3 inches in length. At this location many of the fragments are highly magnetic, and loadstone as strong as any known can be obtained there in great abundance. A few rods from this great outcrop is another of equal dimensions, in which the magnetite is apparently quite free from all impurities, showing neither quartz nor apatite. Near by is another exposure, perhaps a continuation of the last, of which the mass is half magnetite and the other half fine-grained and dense hematite. Across a narrow valley from this group the hillside is covered with fallen fragments of a rich but soft and dark hematite, and at no great distance the soil is colored blood-red by the decomposition of a hematite so soft as to make no other show above the surface. Near this latter location I noticed a line of outcrop of a very jaspery hematite, in some places only a ferruginous jasper closely resembling some of the more siliceous ores of the Marquette district.

As to the age of this remarkable series of iron-ore deposits I cannot speak with absolute certainty, though they are apparently Lower Silurian.

The granite of the hills which contain the iron is finer-grained and less compact than that which forms the great granite axis of the Wasatch, and I suspect is the metamorphic condition of the quartzite beds which rest upon the Wasatch granite. Some of the iron-ore beds in this granite are distinctly interstratified with it, and are certainly, like it, metamorphosed sediments. This is plainly shown at the Blair mine, where the principal crest of the hill is a distinct sheet of stratified, regularly bedded magnetite, from 30 to 40 feet in thickness, dipping toward the north at an angle of about 80°. Parallel with this principal layer are other sheets of magnetite separated by strata of granite and varying from ¼ inch to 10 feet in thickness, as perfectly parallel and regular as any series of sedimentary beds ever seen.

On the whole, the Blair mine is the most interesting and instructive outcrop of iron known to me, and furnishes the most striking proof of the sedimentary origin of these wonderful ore beds. None of the other outcrops are so distinctly stratified, but the Big Blowout at Iron City affords an equally conclusive argument against the eruptive theory; for while it appears to be a huge amorphous mass, like a hill of basalt, on examination it is found to be in large part composed of metamorphosed limonite; that is, magnetite, which has the botryoidal and concretionary aspect and radiated structure of limonite, and was plainly deposited from water.

At the period under review the old Silver Belt district was included in the Pinto district. The former was cut off in 1873, and joined again in 1875. It is located north of Pinto district, and contained at the time of the writer's visit 60 locations. The ore is quartzite, with some copper stain and lead, and assays from $40 to $60 silver per ton. The veins are from 2 to 4 feet wide. The developments are limited.

SALT.—Salt is obtained from the shores of Little Salt lake, near Parowan. It is shipped to the mills at Bullionville, Nevada, and to the Mormon settlements. During the census year about 100 tons were collected. Once when the lake was very low some long fibrous crystals were taken out with a pitchfork. They were sent to some New York chemist, and pronounced to be niter.

WASHINGTON COUNTY.

HARRISBURG OR SILVER REEF DISTRICT.

[July, 1880.]

Harrisburg district, better known as Silver Reef, is in the eastern part of the county, and covers an area of about 5 miles square. The old Mormon town of Leeds was the settlement nearest the mines in early times, and also gave a name to the region. As the mines were developed, the town of Silver Reef was built. It is about a mile north of Leeds, 20 miles northeast of Saint George, and 90 miles south of the town of Milford, on the Utah Southern railroad extension. Daily stages connect it with different points. Wood and water are plenty, provisions are cheap and easily obtained from the Mormon settlements in the Virgin River valley, and the mines are profitable; all of which tends to make the camp a thriving mining town of several hundred inhabitants. Silver was discovered in 1869 by John Kemple, who found, near Harrisburg, a piece of float which assayed $17,000. He filled up his small shaft and left the country, but returned with others and organized the district June 22, 1874. He worked his claims for a few months, when, becoming discouraged, he returned to Star district, and was never benefited by the discovery. The district owes its development entirely to Mr. W. T. Barbee, who went there in the summer of 1875. He discovered very rich ore on the Tecumseh mine, and shipped 10 tons of $500-ore to Salt Lake City in the following November. He continued the shipment of ore to Salt Lake City and to Pioche during the following year. This caused the rush to the district, principally from Pioche, in the summer and fall of 1876. The recorder's books showed 640 locations, but probably not over 150 claims were owned at the period under review. The country rock of this district is composed entirely of strata of sandstone and shale. The upper strata, which have been eroded and are only seen in the distant bluffs, are of a brick-red color. The lower ones, those adjacent to the ore, are pale red or yellowish. The mines are between 3,500 and 4,200 feet above sea-level, and are located wherever these strata of sandstone outcrop. These strata (locally called "reefs") are named White reef, Buckeye reef, and East or River reef. There seems to have been a slight anticlinal fold of the strata, which has been eroded several hundred or thousand feet in depth and many miles in length along its center line, exposing the ore-bearing reefs. The White reef is the most prominent, its outlines, disguised somewhat by weathering and erosion, being traceable for 20 miles. The valuable mines, however, are all within a mile of its northern outcrop. Its general trend is north and south, dipping from 20° to 40° W. The Buckeye reef lies to the east of the northern portion of the White reef, making an angle of about 30° with it. Its dip is from 12° to 25° W. It is less than a mile in length. At its southern extremity, at the Emily Jane works, the silver-bearing strata are only 50 feet apart vertically and 80 feet horizontally. Stratigraphically, without measurements, they appear identical. Hence, from a cursory examination,

it seems as if the Buckeye reef were a triangular piece of the White reef which had been faulted and thrown down. Probably this cannot be better explained than by quoting from the reports of Mr. R. P. Rothwell and Professor J. S. Newberry on the Stormont property, who gave much time and thought to the subject. Mr. Rothwell says:

The remarkable general resemblance between the beds of these two reefs; the curious coincidence of a series of red and gray sandstones and sandy shales, with bands of greenish and red clay shales of the most marked characteristics occurring in precisely the same stratigraphical order in each reef, and, above all, the occurrence of fossil plants and silver ores in certain beds of similar appearance in each, naturally lead to the supposition that these reefs are composed of the same beds cut off between the reefs by a great fault. A closer examination, however, reveals a certain dissimilarity between the ore-bearing beds, and the most careful search has failed to find any data to confirm this theory of a break or fault between the reefs. I have, therefore, concluded that the beds forming the Buckeye reef run under the White Reef.

Professor Newberry says:

* * * These questions are: 1st. What is the geological age of the silver-bearing sandstones? What is the source of the impregnation? Are there two reefs, or is one broken down and duplicated by a fault? The first of these questions has been left unanswered by all who have written on the geology of the district; but I was enabled to obtain conclusive evidence that the sandstones are of Triassic age, and are a part of the great sheet of Triassic rocks which extends through southeastern Utah, southern Colorado, New Mexico, the Indian Territory, etc. In the Cedar mountain, which reaches down from the north nearly to Silver Reef, I found the complete succession of the rocks of this region—Carboniferous, Permian, Trias, Jura, and Cretaceous, each containing its characteristic fossils. I also found some representatives of the sandstones which form the reefs everywhere present in the Triassic group and everywhere containing silver and copper. The question is then finally settled.

In regard to the source of the silver impregnation I had, before going to Silver Reef, accepted and repeated the theory promulgated by those who have written on the subject, namely, that silver solutions coming up through fissures where the volcanic rocks have broken the sedimentary formations, had spread through and more or less perfectly saturated the more porous strata, the sandstones, converting them into sheets of ore. I am now inclined to believe, however, that the silver, like the copper which the sandstones contain, was deposited with them and not introduced subsequently. The evidence of this is furnished by the facts that the extension of the sandstones through the unbroken table lands east of Silver Reef and along Cedar mountains as far north as Beaver *all contain silver*, though rarely more than 7 or 8 ounces to the ton.

Another fact which seems irreconcilable with the theory of the recent diffusion of the silver solution is that some of the richest ore is in the fine clay-shale that lies in sheets and lenticular masses in the sandstone. This material is nearly impervious, and it seems improbable that a solution flowing through the sandstone should have made any considerable deposit of silver in it.

This question has, perhaps, little bearing on the value of your mines—for the diffusion of silver would be sufficiently extensive according to either theory—but the view that the impregnation extends in greater or less richness over hundreds of square miles is in the strongest contrast with that entertained by some, that the ore is local and exhaustible. By whatever means introduced, I am thoroughly satisfied that the ore will be found to extend, not uniformly, but in patches, as hitherto met with, as far as the sandstone ledges can be penetrated.

The question whether there are two silver-bearing beds at Silver Reef, or whether the lower or Buckeye reef has been broken off from the upper or White reef by a fault, has divided the inhabitants of the town into two parties, and is just now quite warmly discussed. As it seriously affects the value of all the mines located on Buckeye reef, and is of vital consequence to the Stormont mine, I gave special attention to it.

If there are two reefs, the Stormont, Last Chance, and Buckeye mines can be profitably worked, perhaps, for a mile down the dip of the reef; but if there were but one, they could be worked only to the line of the fault—perhaps 1,500 feet at the Buckeye and not more than 300 feet at the Stormont. This would render the Stormont comparatively worthless and greatly reduce the prospective value of the Buckeye and Last Chance. I am able, however, to allay any fears that may have been excited by this theory of a faulted reef, for, at the Stormont mine, I found both reefs exposed in the same cliff, and an unbroken series of sandstone and shale beds filling the space between them, thus establishing the fact claimed by Messrs. Rothwell and Couch that there are two reefs.

The River reef, so called because it lies near the Virgin river, is about 4 miles east of the White reef, and has also a north and south strike, but an easterly dip of about 30°. The mines upon this are comparatively unimportant as yet. A few miles southeast of the district several small craters and floods of lava are to be seen upon the extensive sandstone table-lands. In all the mines the ore is found in impregnations of sandstone and clay shale, having an irregular lenticular shape, but usually bedded in distinctly marked strata. The silver usually occurs as chloride and sulphide (about half being chloride), but will doubtless all be sulphide below the permanent water line. There are considerable quantities of carbonized plants, leaves, chips, and limbs usually found in layers a few inches thick, but occasionally distributed promiscuously through the ore. These carbonized fragments are generally exceedingly rich in horn-silver, silver glance, and sometimes a few flakes of native silver, selected pieces of which assay several thousand dollars per ton. But, as with most other ores, appearances are deceptive, and these carbonized organic remains are sometimes valueless. Good ore in the mine cannot be distinguished from waste by color, softness, or granular structure, but the minute flakes of silver can be seen. Freshly broken ore will not show them, but in an hour or so after blasting the gunpowder smoke containing sulphide of potassium has acted upon the colorless flakes on the newly exposed surfaces of the rock and covered them with a film of sulphide of silver having a glistening metallic luster, which is distinctly visible to those accustomed to look for it. The relative number of these small lead-colored specks indicates approximately the grade of the ore. Traces of copper carbonate and sulphide occur in the ore. It is said to be the universal rule that an increase of copper (judging by the carbonate stain) is accompanied by a decrease in the silver value. Professor Newberry reports small quantities of selenium in these ores. The average of four analyses made at the School of Mines gave 0.23 per cent. selenium.

Mills have been erected in the district in the following order: Leeds, February, 1877; Pioneer, 3-stamp, demolished fall of 1877; Christy, January, 1878; Barbee & Walker, March, 1878; Stormont, July, 1878. In 1877

and 1878 many rude leaching works were erected, but, except in cases where the ore was rich and was bought for a trifle, they were unsuccessful. The ore was crushed in arrastras. The percentage saved was from 30 to 60, averaging about 45. Not over $25,000 was extracted in this way.

The total production of the district has been as follows:

Bullion from leached ore and by private conveyance, prior to the establishment of Wells, Fargo & Co.'s office, in 1877, and value of ore shipped (estimated)	$90,000 00
Assay value of bullion shipped by—	
Wells, Fargo & Co. in 1877	480,665 16
Wells, Fargo & Co. in 1878	1,141,911 19
Wells, Fargo & Co. to June 1, 1879	517,444 73
Wells, Fargo & Co. during the census year	1,013,717 84
Total to June 1, 1880	3,243,738 92

A large amount has been paid as dividends by the mill companies, but the exact figures were not obtainable.

Beginning at the northern extremity of each reef the important mines are located in the following order:

White reef.—Barbee & Walker, 2,450 by 600 feet; Pinkham & Dodge; Leeds; Thompson & McNally, 1,313 by 600 feet and 1,490 by 600 feet; and Gisborn.

Buckeye reef.—Silver Flat, 1,498 by 577 feet; Manhattan, 1,500 by 600 feet; Tecumseh, 1,496 by 595 feet, all three belonging to the Christy Company; Kinner, 493 by 300 feet; Buckeye, 1,366 by 489 feet; Last Chance, one-third of a full claim, both owned by the Stormont Company; Maggie, 1,281 by 496 feet; California, 1,422 by 600 feet, both belonging to the Christy Company; 1,497 by 570 feet, and Emily Jane.

East reef.—Vanderbilt, Duffin, Dykes & Stapeley, Toquerville, Maud, and Dixie.

The Stormont Silver Mining Company is a New York corporation having a capital stock of $1,500,000 in 150,000 shares. The early history of the mining property could not be ascertained. The Stormont Company was incorporated July 19, 1879, since which time the mines have been worked steadily. The property consists of the Stormont, the Buckeye, and the Thompson & McNally, patented mines; the Last Chance and part interests in nine unpatented and slightly developed claims; two 5-acre mill sites; and a mill on the Virgin river, 5 miles from the mines.

Buckeye and Last Chance.—The dip of the strata here varies from 14° to 25°. There are several folds or small vertical faults. There is no separation, no distinctly-marked line of fault, but the ore is sometimes thrown from 2 to 6 feet. The extreme limits of the workings, at the period under review, were 148 feet in vertical depth, or about 500 feet on the dip of the reef, and 1,480 feet horizontally. The ground had not been stoped out or even explored, except in some places. The ore had been found in four irregular chimneys, two of which began at the surface. These had a lenticular cross-section, varying from 18 inches on the edges to 16 feet, or even 20 feet, in the center. In general, however, the thickness of the ore stratum was not over 8 feet. The ore stratum is rarely worked when less than 18 inches thick. The total cuttings in these mines were less than 4,900 feet. The company has fine new hoisting works on the Buckeye mine, over a vertical two-compartment shaft 148 feet deep, situated about 500 feet west of the crest of the reef, including a Copeland & Bacon 21 horse-power engine, ⅞ inch steel-wire rope, cages, safeties, etc. These are the only hoisting works on any considerable scale in the district. At the Last Chance there are small steam hoisting works with a 7 horse-power engine. These mines employed about 60 men during the census year; shifts 10 hours and wages $4 per day. The ore is hauled to the mill at a cost of $2 20 per ton.

The Stormont mine—This mine was worked to October, 1879, when the machinery was moved and the work was discontinued. There was a 180-foot incline, 80 feet of which was in water. The other cuttings amounted to 550 feet. One ore body was found from 8 to 15 feet thick in the center and "feathering out" to 18 inches on the edges.

Thompson & McNally.—This claim is on the White reef. The silver-bearing stratum is not over 60 feet from the surface, and has been worked by six short shafts and a tunnel over 200 feet long under the crest of the reef. The extent of the workings is 60 feet in depth from the surface, 400 feet in length, and 350 feet on the dip of the reef. The total cuttings amount to 1,220 feet, besides large open cuts. The ore is found in several lenticular bodies. Many thousand tons have been produced. About 38 men were employed during the first half of the census year, since which time the mine had been idle.

The Stormont mill is situated in the ravine of the Virgin river, from which it obtains water by a ditch 1 mile in length. The mill was completed July 4, 1878, and has been running most of the time since. The mill plant consists of a 40-inch turbine water-wheel; a boiler to generate steam for pans; a Blake crusher; 2 self-feeders of local invention; 10 750-pound stamps, double-discharge, wet-crushing batteries, No. 40 brass wire screen, drop 6 inches, speed 94; 24 settling tanks, 5 by 7 feet 8 inches by 3 feet 6 inches; 13 pans, 6 feet 4 inches by 2 feet 8 inches; 7 settlers, 7 feet 10 inches by 2 feet 10 inches; 3 retorts; 2 melting furnaces; and 120 feet of blanket sluices, having six compartments 13 inches wide. The whole cost about $55,000. The turbine has been running almost steadily for a year and a half, and has given great satisfaction. It has become much worn, using one-third more water than formerly, and is soon to be replaced by another of the same make. The head of water

is 20 feet, the penstock is 8 feet 2 inches square, and the flume is 8 feet 2 inches wide, and 24 inches deep. The average amount crushed per day is from 70 to 75 tons. Sometimes the battery is hung up for one or two hours at a time, because the tanks and pans are full. Battery shoes and dies last about 40 days, about two-fifths of a pound of iron being worn off per ton of ore crushed. Screens last two weeks. The battery sands flow into a single settling tank at a time, the overflow passing through all the others. The heavy sands are shoveled out upon a platform, and thence into the pans. The lighter sands or slimes are pumped into the pans to give the required consistency. About 10 per cent. of the ore passes off in slimes and settles in three slime ponds, which are from 50 to 80 feet square and 1½ feet deep. These slimes assay about $35. When nearly dry, they are wheeled to an elevator, taken to the pan floor, and mixed with the ore and concentrations. The pan mullers make 62 revolutions per minute. A charge is a ton and a half and is worked six hours. The temperature, as observed at the time of the writer's visit, was 136°, 140°, and 153°. Grinding is never done. At the time of charging 200 pounds of mercury, from 20 to 50 pounds of salt, and from one-half pound to 4 pounds of sulphate of copper are added per pan. The difference in the quantity of chemicals employed is due to the difference of the ore from different mines, experience having determined these quantities. There is a peculiarity of construction of these pans, which is of considerable advantage. The driving rod, which runs through the center of the pan and carries the muller, is prolonged upward 4 feet beyond its usual length, and bears the thread of a large screw. On one side the entire length is a key-seat. The muller, provided with a screw, as usual, moves upon the rod, and, by means of the key and key-seat, can be securely fastened at any height. This is of great advantage in cleaning up the pans. The muller is screwed up and fastened, and the labor of hoisting it was thus avoided. The settlers make 12 revolutions per minute, and retain a charge three hours. They are run half an hour, and run down in two and a half hours. The mill is thoroughly cleaned up once a month, and the quicksilver weighed. The loss is from three-quarters to one pound per ton of ore worked. The retorts are cylindrical, 1 foot in diameter and 4 feet long, and hold about 800 pounds of amalgam. They last about 90 charges. The bullion is 0.820 to 0.980 (average, 0.850) fine, the remainder being copper. The tailings, which assay from $3 14 to $8 copper, are concentrated on blanket sluices having a grade of about 8 inches to the rod. The blankets are washed twice in 24 hours, and about 20 tons, assaying from $20 to $60, are caught in three weeks. These concentrations are allowed to weather from three to four months, and are worked in pans mixed with other ore. The tailings from the blanket tables run off into the Virgin river. Battery samples are taken every hour, one pint from the spout at the rear of the screens, care being taken not to run the dipper over. These are settled and made a 12-hour sample. Tailing samples are taken in the usual manner. Very complete estimates of costs and percentages are made each month, but they were not given for publication. Besides working the ore from the company's mines, this mill does considerable custom work. The company charged $12 per ton for milling, deducting 3 per cent. for moisture; pays 80 per cent. in bullion for ore assaying $60 and upward, 75 per cent. in bullion for ore below $60, and cashes the bullion at 20 per cent. discount if so desired. The cost of treating ore by this water-power mill is about a dollar per ton greater than if the mill had been erected at the mines and steam-power used; this is owing to the expense of hauling the ore. The mill force consists of:

Class.	Number employed.	Length of shift.	Wages per shift.
		Hours.	
Amalgamators	4	12	$5 00
Dumpmen	6	12	4 00
Tankmen	8	12	4 00
Battery feeders	2	12	5 00
Slime-pit men	4	12	4 00
Blanket washers	2	12	4 00
Watchmen (ditch)	2	12	4 00
Laborers	2	12	4 00
Blacksmiths	2	12	5 00
Carpenter	1	12	6 00
Assayer and foreman	1	12	5 00
Clerk	1	.....	3 33
Superintendent	1	.....	.....

The Christy Mining and Milling Company owns the Tecumseh, Silver Flat, Silver Crown, Silver Point, Chloride Chief, Maggie, and California, all patented claims; 18 others, unpatented; and 19 acres of land, including a water right and a mill and mill site in the town of Silver Reef. The company was incorporated in the fall of 1877, having a capital stock of $6,000,000 in 60,000 shares. The following claims were the only ones which have been developed to any extent:

The Manhattan, Silver Flat, and Tecumseh.—These are situated at the northern end of the Buckeye reef on an almost level surface. The ore is found here, from 4 to 15 feet below the grass, in comparatively small bodies, from 1 to 3 feet thick and from 40 to 50 feet wide and long. There are 800 feet of cuttings and a large amount of

surface work. Several faults of from 4 to 6 feet and wave-like formations were noticed by Professor Maynard, who made a report on the property in the summer of 1880. The company employed about 26 miners during the census year, and produced over 13,000 tons of ore from all its mines. The cost of transportation to the mill was 80 cents per ton.

The California and the Maggie.—These are at the other extremity of the same reef. They have small steam hoisting works (8 horse-power engine), at a 200-foot incline on the dip of the stratum (25° W.). A small quantity of water was encountered at 75 feet from the surface, and was raised by steam pumps. Below the water line the ore was not so free. The drifts and levels extend 800 feet horizontally, and amount to about 2,100 feet. One ore body began at the surface and extended to the 150-foot level. Others have been found which extended below the existing workings. The ore bodies are rarely more than 30 inches in thickness. About 18 men were employed during the census year.

The Christy mill.—The plant comprises one 40 horse-power engine; one Blake crusher; one Hendy self-feeder; five 850-pound stamps (double discharge, wet crushing battery, drop from 5 to 7½ inches, speed 95, No. 40 brass-wire screen); 12 settling tanks (8 are 3 feet 8 inches by 8 feet 10 inches by 2 feet 10 inches deep, and 5 are 8 feet square and 2 feet 10 inches deep); 6 pans, 5 feet 6 inches by 3 feet (2 more were to be added soon); 3 settlers, 8 feet by 3 feet 4 inches (1 more to be added soon); 2 retorts; and 2 smelting furnaces. This mill began operations January 8, 1878, and, with few interruptions, has been running steadily since. Its capacity is about 40 tons per day. According to the foreman, about one-fifth of a pound of iron is worn from the battery shoes and dies per ton of ore crushed. Cams and stems begin to break after twelve months' wear. Screens last seven days. It is estimated that about 15 per cent. of the ore passes from the mill as slimes. These are caught in four large slime pits, about 75 feet square and from 3 to 5 feet deep, and are treated as at the Stormont mill, *i. e.*, mixed with one-third of a charge of the coarsest sandy ore and put through the pans. In working slimes more mercury is lost and a lower percentage (estimated at 3 per cent.) obtained than in working the regular ore. The pans work a charge of 1½ tons in six hours, making seventy revolutions per minute. The temperature, as observed, is from 160° to 170°. About 30 pounds of salt, 2 pounds of bluestone, 1 pound of lye, and 250 pounds of mercury are added per pan at the time of charging. A few ounces of cyanide of potassium are also added every two or three days to clean the mercury. The settlers make thirteen revolutions per minute and run three hours, two to settle and one to discharge. The mill is cleaned up once per month. The loss of quicksilver is 1½ pounds per ton of ore treated. The bullion is about 0.930 fine.

The following peculiar action of the bullion was noticed in this district, and especially at the Christy mill, when working on some Tecumseh ore, which contained a number of minute yellow specks. After the bullion was poured from the pot into the mold and had apparently solidified, it would begin to swell (not sprout) and rise slowly in the mold until the spongy surface was from 3 to 4 inches above the first surface. The melter noticed that this action was prevented, or at least diminished, by keeping the molten silver in the pot a considerable time before pouring. A person, said to be connected with the laboratory of Hamilton College, New York, while visiting at Silver Reef, took some samples of these yellow ores, and, on returning to the east, reported that they contained phosphate of uranium. This statement has not been authenticated, but is given for what it may be worth.

Assays are regularly made at the Christy as at the Stormont, but all data were confidential.

The Barbee & Walker Silver Mining Company was incorporated June 1, 1880, with a capital stock of $1,000,000 in 100,000 shares. The company owns two patented claims, embracing 2,450 by 600 feet of ground along the White reef, a 5-stamp mill, and 14 acres of agricultural land to insure a water supply. The company has small steam hoisting works on a 400-foot incline, which began on the crest of the reef. The engine is of 21 horse-power and the rope ⅞-inch steel wire. A giraffe is used. The plant is thought capable of sinking 600 feet on the present dip of 40°. The ground has been prospected 706 feet horizontally, and the total cuttings amount to 2,180 feet. No water has been yet encountered. The ore is found usually on the hanging-wall side of three beds, about 12 feet apart, and dipping 30° to 45° W. One body came to the surface, and was 200 feet long, 60 feet wide, and from 2 to 20 feet thick. Several others of much smaller size have been encountered. One vertical fault of 6 or 8 feet and several smaller faults of the ore in the beds have been met with. The beds are not worked, except when prospecting, when the ore is less than 12 inches in thickness. About one-tenth of the drifts require timbering. Black powder is used almost exclusively. The volume of a ton of ore or waste in place is estimated at 12½ cubic feet, and of a ton broken at from 18 to 23 cubic feet. The mine was idle, owing to the destruction of the mill by fire, except during the last three months of the census year, when about forty-four men were employed. Night shifts are nine hours and day shifts ten, and the wages are $4 per shift. Drifting is done by contract, the company furnishing and sharpening the tools, and paying $7 50 per linear foot. The ore is not weighed, but estimated in bulk by the tally-board of the car-loads hoisted. The cost of mining ore per ton for the month of June, 1880, was $5 29. The total assay value of bullion produced from ores of this mine, between April, 1878, and June 1, 1880, was $244,577 90.

The company's mill is on the side of the reef below the hoisting works. Ore is taken in a wheelbarrow 100 feet or less from the mine dump into the mill. The mill was built in the spring of 1878, and was accidentally burned June 23, 1879. It was rebuilt and began running again February 23, 1880. It has been in operation continuously since. The machinery consists of a 25 horse-power boiler and engine, a home-made self-feeder, a Blake crusher, five 650-pound stamps (double-discharge, wet-crushing battery, 5½- to 6-inch drop, speed 90 to 95, No. 40 screen),

three settlers 7 feet 10 inches by 2 feet 10 inches, two retorts, and two melting furnaces. The capacity of the mill is about 35 tons per day. The stamps could crush more, but there is not sufficient pan capacity. About 10 per cent. of the ore passes off as slimes and is caught in three slime ponds 50 by 65 feet and from 3 to 5 feet deep. These slimes for the month of June, 1880, assayed $54 per ton. When dry they are added to the regular pan charges, 200 pounds to each charge. The pans hold about a ton and a half each, make 55 revolutions per minute, run six hours without grinding, and have an observed temperature of from 182° to 188°. Immediately after charging and heating up the pans, 180 pounds of quicksilver, 30 pounds of salt, 6 pounds of bluestone, and an ounce or so of cyanide of potassium and lye are added to each charge. The settlers run one hour before discharging. The mine is cleaned up on the first of every month. The loss of quicksilver is 1.4 pounds per ton of ore. The bullion is 0.860 fine. The tailings for June, 1880, averaged $8 52. They are all saved in reservoirs below the mill. Assays are carefully and regularly taken, as in the previously-mentioned mills of the district. The average assay of battery samples from December, 1878, to June, 1879, was 20.3 ounces. The average in June, 1880, was $33 06. The cost of the mill was $26,000. The cost of milling ore in June, 1880, was $6 40 per ton. No custom ore is worked. About 1,015 tons were treated in June, 1880, yielding $26,334 53. The mill force was 17 men, working 12-hour shifts, at $4 and $5 per shift.

The Leeds Mining Company, capital $6,000,000 in 60,000 shares, was organized in the autumn of 1877. The company's property consists of four adjoining claims on the White reef, one mill and mill site, and 15 acres of land and its water right. The mines have been opened by a tunnel running under the crest of the reef and by six shafts. The extreme extent of the workings is 900 feet on the dip (20°) and 900 feet horizontally. The total cuttings probably exceed 5,500 feet. There is only a whim on one of the shafts. Several bodies have been found from 1 to 15 feet (average, 6 feet) thick. The richest ore is usually on the foot wall or floor. About eighteen men were employed during the census year, and 4,923 tons of ore were extracted. The mine had been idle several months.

The Leeds mill was originally the Magnet mill, erected at Bullionville, Nevada, years ago, and was moved to Silver Reef in the winter of 1876. It is about a tenth of a mile from the mines of the company. The plant consists of a 35 horse-power engine and boiler, a Blake crusher, a self-feeder, ten 750-pound or 800-pound stamps (double-discharge, wet-crushing battery, 6½-inch drop, speed 95, No. 40 screen); ten settling tanks, ten pans, 4 feet 6 inches by 2 feet 2 inches; five settlers, 7 feet by 2 feet 2 inches; two retorts, and two melting furnaces. It was one of the old-style mills, and showed the effects of a move and hard work. It had been idle for some months. There is nothing about the mill or its working results so different from those previously described as to require particular mention. Besides working the company's ore, much custom work has been done. The price charged was $12, lately reduced to $8 per ton. The mill guarantees 80 per cent. in bullion, and buys bullion at 20 per cent. discount. The total assay value of bullion produced by this mill to June 1, 1880, including that from custom ore, was $768,321 58.

The Kinner mine, on Buckeye reef, has small steam hoisting works (10 horse-power engine) over a vertical shaft. The limit of explorations is 250 feet horizontally and 450 feet on the dip, or 175 feet vertically. The cuttings amount to 1,200 feet. Some water, 300 to 400 gallons per hour, was encountered at 350 feet on the dip. Several bodies have been found having an average thickness of about 5 feet. The richest ore occurs within from 10 to 15 inches of each wall, *i. e.*, near the overlying and underlying strata. The strata are folded in one place in the mine something like a letter "S", and are also said to be faulted and thrown 40 feet. During the census year 32 men were regularly employed, and about 2,700 tons of $40-ore were extracted. The former product was $15,000. The ore was milled at custom mills, but, owing to the high price of milling and lack of economical hoisting machinery, even high-grade ore did not pay, and the mine has been idle several months.

The other mines of the Harrisburg or Silver Reef district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	Feet.			
Pinkham & Dodge	727	No ore shipped	Assessment work only	Large bodies of $16 ore.
Emily Jane		280 tons	Worked on lease	Ore, $20 and $30. Developments limited.
Vanderbilt		240 tons		Average of ore produced, $100. Incline of 60 feet.
Duffin	900			Total product, many hundred or thousand tons of $80 to $100 ore.
Tecquerville	1,000		Worked by chloriders	Several hundred tons of $50 ore have been shipped.
Maud	440	$33,000	Worked irregularly	Ore assays from $30 to $100.
Dixie	190	400 tons		Ore produced valued at $35 per ton.
Gisborn		500 tons		Value of ore produced, $20 to $25 per ton.

SANTA CLARA DISTRICT.

[July, 1880.]

The Santa Clara district is situated 10 miles west of Saint George on what seems to be a continuation of the Silver Reef silver-bearing sandstone strata. It was organized in the spring of 1880. There are a few locations which have about 100 feet of cuttings each. The pay stratum is said to be 8 feet thick, assaying from $10 to $15 per ton. Around Saint George, and between it and Silver Reef, there are several districts, Volcanic, Gunlock, and others, covering miles of sandstone country, and containing many locations. Little work, however, has been done and no ore shipped.

Sulphur in considerable quantities is found near Tocquerville. The Mormons claim that a vein of graphite from 1 to 3 feet wide exists in the mountains northwest of Saint George. There is also said to be graphite in Kane county.

The Pahria excitement occurred in the early part of 1879, and was occasioned by the report that a reef of silver-bearing sandstone had been discovered about 125 miles east of Silver Reef. This mythical reef, according to the report, was many miles long and averaged $50 per ton, not counting the rich spots which assayed among the hundreds. Over 500 men, including some capitalists from Salt Lake City, rushed off to the new camp. Nothing was found but reefs of sandstone assaying a few dollars, although bearing a strong resemblance to the rich ores of the Silver Reef mines.

The Grand Gulch copper mine, in Bentley district, is 40 miles south of Saint George and 15 miles north of the Colorado river. Geographically it belongs to Arizona; but, if ever worked, it will necessarily obtain its supplies from Utah. The district was organized in 1871. Wood is plenty. Water, however, is scarce and 8 miles distant. A few copper locations have been made. Of the mine little can be said, as the reports are so conflicting. Considerable 30 to 50 per cent. copper ore has been found in sandstone. In 1877 the property was leased to men from Salt Lake City, who sank a 100-foot shaft, built a reverberatory and a shaft furnace, and ran out 10 or more tons of copper bullion. Nothing has been done since.

MORGAN COUNTY.

MILL CREEK DISTRICT.

Mill Creek district is 10 miles southwest of Weber, on the Union Pacific railroad, and contains a few iron claims having traces of gold and silver. The Norway Iron Mining and Milling Company owns three claims here, which are said to contain large quantities of high-grade iron ore. This company was incorporated November 19, 1879, with a capital stock of $1,000,000 in 100,000 shares. The work on the claims is limited in extent, and no iron furnaces have been erected owing to the lack of capital.

WEBER COUNTY.

WEBER DISTRICT.

[January, 1881.]

The Weber mining district is on the Wasatch range, 2 miles northeast of the city of Ogden. Junction district formerly covered this ground, but its organization was abandoned about 1860. Weber district was organized in February, 1878, and contained at the period under review about 130 locations. The claims were mere prospects, few having over 100 feet of cuttings. The country rock is limestone and quartzite. The ore is an ocher, low grade in silver and lead, and a quartz said to average $20 in gold. There are two arrastras and one small reverberatory roasting furnace in this district. From 3 to 8 miles north of Ogden there are said to be large deposits of hematite and magnetite ore. In 1874 a company was organized to work this iron ore. It built a furnace and ran a week in 1876. There is also considerable rolling-mill machinery upon the ground. It was said that $125,000 was spent by the old company.

BOX ELDER COUNTY.

WILLARD DISTRICT.

[January, 1881.]

Willard district was organized about 1874. Little was done until the spring of 1880. There were, at the period under review, 40 prospects. The Iron King is a very large mass of iron ore, 3 miles northeast of Willard. Only assessment work had been done to hold it. Antimony ore occurs in reniform masses, from nut to bushel-basket size, in a quartz vein about 4 miles north of Bingham City. There have been no developments and no ore has been shipped.

LUCIN DISTRICT.

[January 1881.]

Lucin district is 8 miles long and 2 miles wide, and is located partly in Nevada. The mines, however, are entirely in Utah, about 8 miles southeast of Tecoma, on the Central Pacific railroad. It was organized in 1869. About 200 locations had been made, but not over 15 were claimed at the period under review. Very little has been done since 1876. The country rock is limestone.

The English Tecoma company, or the Tecoma Mining Company of Utah (limited), owns several claims, two of which, the Gladstone and the Shanly, were patented, upon which much work was done in 1873, 1874, and 1875; since which time they have been idle. This was the same company that bought the Flagstaff and the Last Chance. About 1,000 tons of low-grade ore (30 per cent. lead and from 10 to 25 ounces silver) was extracted, which was shipped to the company's furnace at Truckee, California, about 500 miles distant. The total cuttings aggregated possibly 1,500 feet.

The American Tecoma Company, or the Tecoma Mining Company, owned eight patented claims. A furnace was erected in 1871; and while the mines were looking well the property was sold to Howland & Aspinwall, of New York, in 1872. The latter owners extracted several thousand tons of ore (averaging about 35 ounces silver and 45 per cent. lead) from two well-defined surface bodies, and shut down in 1875 or 1876. The claims have been idle since. In the lower parts of the ore bodies much wulfenite was found. Their total cuttings amounted in the aggregate to about 1,200 feet.

In 1874 about 40 tons of horn-silver ore were collected on the Black Warrior claim from surface deposits by gopher-hole work, which were said to have yielded $16,000. Little has been done since.

There are a few other claims, the Buchu, the Central Pacific, the Lady Franklin, and others, which have a few hundred feet of work and have produced a small amount. Five men were chloriding and prospecting in the district in the census year.

NEWFOUNDLAND, SILVER ISLET, ROSEBUD, ASHBROOK, AND FREMONT ISLAND DISTRICTS.

[January, 1881.]

Newfoundland district is situated in a small mountain range in a marshy desert 15 miles south of Terrace, on the Central Pacific railroad. It was organized in 1872. Many locations had been made, though few claims were owned at the period under review. It is said that the formation comprises all the sedimentary rocks and some porphyry. The veins are narrow (18 inches), and contain milling ore assaying from 100 to 150 ounces silver and some copper. Assessment work has been kept up on a few claims having from 150 to 250 feet of cuttings each.

Silver Islet district is on another mountain in the same desert. There are a few claims having high-grade copper ore which have been comparatively idle since 1873.

Rosebud district, 10 miles northwest of Terrace, was organized in the fall of 1873, and contains probably 200 locations, of which 25 were still worked at the period under review. The country rock is said to be limestone, quartzite, and porphyry. The ore is an ocherous carbonate of lead containing a few dollars in gold and from 60 to 100 ounces in silver. The Thompson Consolidated Mining Company owns four claims, and is doing the principal work. There is a 300-foot shaft and incline; also 400 feet of other cuttings. Eight men have been working during the year. Other claims in the district having a few hundred feet of cuttings are the Talco Consolidated, Silver Reef, Mayflower, and Delmonte. Very little ore has ever been shipped.

The Ashbrook district, organized in 1874, is about 30 miles northwest of Terrace, in the extreme northwestern corner of Utah, and contains a few narrow veins of high-grade free-milling silver ore. Thirty tons were shipped in September, 1880.

About 20 miles northwest of Terrace, on Grouse creek, there are two belts of coal croppings. There are seven seams of coal and shale from 3 inches to 4 feet thick about 20 feet apart. Ten tons of a fine quality have been shipped. At the period under review a few men were prospecting the beds in the interest of the Central Pacific railroad.

Fremont district, which includes the whole of the island of that name in Great Salt lake, was organized in 1871. Small veins carrying gold, silver, copper, and lead were found. Nothing was done, and the organization has been abandoned. There is said to be a great abundance of very good roofing slate on the island.

GREAT SALT LAKE.

The Great Salt lake has an area of 2,360 square miles (including islands), is 4,218 feet above sea-level, and has a maximum depth of 60 feet and an average depth of about 20 feet. The water-level has varied several feet within the memory of the old settlers. Between 1847 and 1856 it filled 5 or 6 feet and receded to its old level. In the few years following 1863 it filled again, and has maintained that depth since. In consequence of this the percentage of solid matter in solution is variable. An analysis made in 1869 gave 14.8 per cent. of solid matter,

of which 11.8 per cent. was sodium chloride. Salt has been collected by the Mormons since their arrival in the country in 1847 from small ponds on the shores, which became dry in the autumn. It is, however, only within the last few years, since a demand for it has arisen at the new mills in the adjacent territories, that any systematic arrangements have been made for gathering it.

There are six places on the lake shore where salt is obtained, Monument Point, Willard, Plain City, Hoopersville, Farmington, and near Salt Lake City. Sometimes the lake water is pumped into artificial ponds by steam or horse-power, and sometimes a dam is built across the entrance to a small cove on the lake shore. In either case the salt is obtained by solar evaporation. The most extensive works are those of Jeremy & Co., near Salt Lake City, to whom the writer is indebted for the following particulars relating to the process and the costs: The dam across the cove must be solidly built; earth will wash away and plank will not bear the weight of the waves of heavy salt water. Experience has proved that it must be made of earth and covered with lattice, willows, and tule. Posts are driven 2 feet apart in two rows 7 feet apart. A lattice work of willows is woven on these posts and backed by several inches of tule, the center being filled with earth. Such a dam costs about $1 per foot. There is a gate through this dam, or around one end of it, through which the water flows when it is raised in waves by a strong west wind. These salt ponds are from five to a hundred acres in extent. The season is from May to October, the first three months being required for the evaporation of the water. The salt will be found in crusts from 1 to 4 inches thick. It is scraped into conical heaps with a square-edged shovel. The men receive from 50 cents to a dollar per ton, and make wages of from $2 to $2 25 per day. A cubic foot of salt in the heap is estimated at from 65 to 74 pounds. The price of salt per ton at the ponds varies with the demand, but is usually between $2 50 and $4. This firm estimates the product of its works during the census year at 10,000 tons. At the other ponds about 4,700 tons were gathered. From inquiry the writer estimates that only about 7,000 tons were shipped to mills, by rail, and used for domestic purposes during the same time; hence the remainder is still standing in the conical piles, dissolving and washing back into the lake with every rain.

COAL FIELDS.

The supply of coal in Utah is apparently inexhaustible, but only a few beds in the most accessible localities have been worked. The coal is a "brown coal", like all that has been discovered in the Rocky Mountain region.

The records of the Salt Lake City land office show that between 1870 and 1879 the following acreage of coal land was returned on the plats of public surveys:

	Acres.
Kane county	49,384
San Pete county	34,332
Sevier county	11,013
Iron county	6,240
Wasatch county	2,840
Summit county	19,931
Total	123,740

This does not include it all. Much land was surveyed between 1856 and 1870, of the character of which no mention was made; and vast tracts in the southeastern coal region are unsurveyed. But a few thousand acres are either located or patented.

In the following localities comparatively limited developments have been made:

THE COALVILLE DISTRICT, SUMMIT COUNTY.

[November, 1880.]

In the valley of the Weber river 2,000 or 3,000 feet of the overlying sandstone has been eroded, thus exposing the coal series of the Green River basin near its western border. This coal series belongs to the Laramie group of the Cretaceous period. (a)

The purely Mormon town of Coalville is situated 5 miles south of Echo, up the valley of the Weber river. Two parallel streams, Chalk and Grass creeks, flow from the northeast into this river, the former at Coalville, and the latter a few miles further down. It is on these two creeks, or in their side ravines, where the coal was almost or quite in sight, that the Coalville mines are situated. The altitude is from 6,500 to 6,800 feet. The coal croppings are principally found in a region 15 miles east and west by 8 miles north and south, but the mines actually worked are in a much smaller area. The country is considerably broken, most of the mines showing one or more faults, although the distance of the throw is usually not great. To the eye the surface of the country presents a succession of three sandstone ridges, with strata dipping from 20° to 30° between north and west. This indicates three extensive faults, which will be found when two of the coal beds are worked to great depths. There are two principal beds of coal,

a Geol. Expl., 40th Par., by Clarence King, 1869, Vol. III, pages 451 and 467.

the upper or 5-foot seam, having a red ash, and the 11-foot seam, which is worked at present. The perpendicular distance between these beds is said to be 800 feet. In the period between 1864 and 1874 the other principal mines were discovered and work was begun. Since then operations have been irregularly continued, usually in the winter. In general the mines have been worked by poor men. The machinery used has been very small and imperfect, the system of working very short-sighted, and the profits little or nothing. The mines have usually been leased at a royalty of 25 cents per ton. Much trouble has occurred regarding this royalty and as to titles.

There are eight openings, hardly entitled to be called mines, from which coal had been extracted, in the Grass Creek cañon, viz, Cupley's opening, Bull Hollow claim, Hodgdon & Flatcher's claim, The Bishop's mine, Grass Creek mine, Muir & Co.'s mine, and the Robinson or Church mine. Only the four last mentioned have been worked to any considerable extent.

The Bishop's mine is on the 11-foot seam. It was opened about 1870, and has yielded 10,000 tons or more of coal. In 1877 it was sold for $60,000 to the Union Pacific Railroad Company, which now owns it. It was idle at the period under review.

The Grass Creek mine, 6 miles from Coalville, is a new opening on the Bishop's mine. Work was begun May 20, 1880. The Union Pacific Railroad Company was placing machinery able to work 2,000 feet or 3,000 feet on the dip of the bed, and was making preparations for a large and permanent yield. The size of the claim is 640 acres. The seam is 10 feet thick, and the dip is from 30° to 39° N., 25° W., and increases with depth. No faults had been found in the 220 feet of main slope. Water was encountered 40 feet below the surface, but not in large quantities. The machinery is to consist of one very large horizontal engine, coupled, power unknown, drum 10 feet, and steel-wire rope 1⅝ inches in diameter; three horizontal boilers of 150 horse-power, and steam pumps. An ordinary broad-gauge track connects the mine with the branch of the Union Pacific railroad running from Echo up the Weber river. Only 50 tons are raised per day.

Muir & Co.'s mine was opened in 1874 on ground leased from the Robinson claim. It is worked through two tunnels. Coal has been extracted in an area 600 feet deep and 1,000 feet long. It was idle at the period under review.

The Robinson or Church mine is situated at the head of Grass Creek, 8 miles northeast of Coalville. It has an area of 320 acres, and is owned by the Mormon church or some of its leaders. It has been leased to Mr. Robinson at a royalty of 25 cents per ton extracted. It is worked through a 300-foot tunnel and has no machinery. There are several faults of 4 or 5 feet running north and south, and one vertical fault of 150 feet, which separates it from the Muir ground.

The total coal product of the Grass Creek mines prior to June 1, 1879, is rather vaguely estimated by old residents at 50,000 tons.

The mines of Chalk Creek have been worked far more extensively than those mentioned above, and are all within 2½ miles of Coalville. They are the Spriggs, Black Diamond, Wasatch, Crismon, and Allan.

The Spriggs mine is in the town of Coalville, and has been worked yearly, yet somewhat irregularly, chiefly by lease, for twelve or fourteen years. The mine was once operated vigorously by Buel & Bateman. The property consists of 160 acres of patented land, a small 15 horse-power engine, and three Knowles steam pumps. There is but one coal seam, from 10 to 11 feet thick, dipping 25° NW., underlaid and overlaid by clay and a light-yellow, fine-grained, fossiliferous sandstone. One fault of 10 feet, running SW., is known to exist. The old Buel & Bateman workings extended 600 feet on the dip and 1,200 feet horizontally. They had caved in, been on fire, and are now walled up. The new works have a 450-foot incline and a horizontal development of 310 feet. Part of the roof has caved, owing to the removal of the pillars. In the busy season 60 men are sometimes employed.

The Black Diamond Coal and Coke Company is a Salt Lake company that had leased a part of the Wasatch ground. Work was begun a few years ago, but the present company did not buy the lease until the spring of 1880. It owns the Allan mine and several coal prospects on 5,000 acres of unpatented coal land. In this mine the coal is 10 feet thick. The machinery consists of a horizontal engine of 12 horse-power, with friction gearing, ¾-inch steel-wire rope, and two Knowles No. 4 steam pumps. The main incline is down 400 feet on a dip of 25°, and the horizontal workings extend 350 feet.

The Wasatch mine is a claim of 160 acres. It has been worked through a tunnel at irregular intervals since 1866, and has yielded well. In July, 1879, a vertical working shaft was begun, which struck the coal bed at 92 feet. The mine is hardly opened, but few levels having been driven. The machinery consists of a vertical 11 horse-power engine and a Blake No. 4 steam pump.

The Home Coal Company was incorporated November 1, 1880, with the object of controlling and insuring the supply of coal to the Ontario mine and mill. The property comprises the Wasatch, Spriggs, and Crismon mines.

The Crismon mine was discovered in 1870, and has been worked since. There are several old tunnels from which large amounts of coal have been taken. The machinery in use at the period under review was erected in 1874, and consisted of one very old 12 horse-power engine, one No. 4 Crane steam pump, and a ¾-inch steel-wire rope. The size of the claim is 40 acres. The coal seam is from 9 to 14 feet thick, dipping 13° W. of N. One fault of 2 feet, running southeast, and a "ditch" of 10 feet has been found. The extreme development, not including old workings, is 600 feet on the dip and 1,200 feet horizontally. The pillars are 30 feet wide, and the "stalls" or "rooms" are 16 by 100 feet. The mine has been on fire on the east side of the main slope above the 420-foot level for seven years, but the burning part is walled off from the rest and gives no trouble.

The Allan mine was opened in 1864. A fault was encountered in 1870, and the mine was idle for two years. A second fault was found in 1877, and the mine was abandoned. An attempt is to be made shortly by the owners to find the faulted bed. The main incline is down 600 feet, and it is estimated that three acres had been worked out before the mine shut down. The seam is of clean coal, 12 feet thick, which is generally conceded to have been of better quality than that of any other mine in the neighborhood.

This completes the list of the mines in the Coalville district. There are a few prospects in the vicinity and considerable coal croppings 10 miles up Chalk creek, and also near Wanship. Little, however, has been done. In all the mines of this district the coal is a non-coking "brown coal". Occasionally thin scales of pyrites and gypsum are found, but no resins or iron ore. It checks considerably when exposed to the sun. In mining about one-quarter is slack. Water is found near the surface in all the mines, but the quantity does not usually exceed from 500 to 600 gallons per hour. There is no marked change in the quality of the coal at the water line.

The following are some analyses made by O. D. Allen in 1869. (*a*)

Mine.	Specific gravity.	Water.	Total volatile matter.	Fixed carbon.	Ash.	Carbon corresponding to volatile matter.	Total carbon.	Units of heat.
Spriggs	1.32	1.68	47.27	48.78	3.95	20.44	69.12	5,585
Wasatch	1.31	8.38	47.06	49.68	2.26	26.49	76.17	6,154
Allan	1.29	9.89	47.34	49.35	3.31	20.65	70.00	5,656
"Church"	1.32	9.42	48.21	48.27	3.52	25.65	74.12	5,989
Crismen	1.31	9.83	47.46	48.91	3.60	20.79	69.70	5,632

In working the mines no safety lamps are used. The rooms and pillars are usually 20 by 100 feet each. From 8 feet to the entire thickness of the coal bed is worked. A row of timbers is required in the center of each room. About one-half the coal was left standing at the period under review, very little "working-out" having been done. The work is done almost entirely by contract, the miners furnishing their own supplies and receiving 90 cents per ton of 2,000 pounds for breaking down the coal and loading it into cars. In drifting or sinking, "yardage" is given in addition to the coal extracted. "Yardage" is 75 cents in the galleries and $4 on the main slope. Average workmen make $2 50 per day. The cost of each of the four small hoisting works was from $3,000 to $6,000. The cost of mining coal is about $1 25 per ton, not including the royalty of 25 cents. The selling price at the mines is from $2 to $2 25 per ton. The market for the coal raised in this district is local domestic use, Salt Lake City, Union Pacific railroad locomotives, and the Park City mines and mills. Heretofore two- and four-horse Mormon teams have hauled the coal to Park City—distance 22 miles—for about $8 per ton; but a branch of the Union Pacific railroad, called the Summit County railroad, and a narrow-gauge road known as the Utah Eastern railroad, are to be completed to Park City in a few weeks, which will have the effect of lowering the price about one-half. This coal sells for $8 50 in Salt Lake City, and is transported partly by the Union Pacific railroad via Ogden, and partly 45 miles across the country in Mormon wagons.

The total production of coal by this district prior to June 1, 1879, as near as it could be obtained from the several mines, has been only about 190,000 tons. The product during the census year was about 30,000 tons.

THE PLEASANT VALLEY COAL MINES.

Pleasant Valley is in San Pete county, southeast of Springville. Many thousand acres of coal lands have been located and several mines opened, but the railroad company's mine is the only one worked. There are two, and, perhaps, three different beds of coal. The upper one, which has not been worked, is a 5-foot bed of very resinous coal. A few hundred feet below this, in various places, beds of clean coal, 11, 16, and 30 feet thick, have been found. It is not known whether these belong to the same bed or not, as the croppings are several miles apart. The surface of the country is covered with low, gently-rolling hills. The mines are reached by a narrow-gauge road, the Utah and Pleasant Valley railroad, 54 miles long, through Spanish Fork cañon. This road begins at Springville, on the Utah Southern railroad, 4,550 feet above sea-level, and gains the summit (altitude, 7,917 feet) in 44 miles. It then descends into the valley (altitude, 7,550 feet) and finally ascends a short ravine to the workings.

Coal was discovered here in 1876 by Mark Crandal. He and one Packard started the railroad and sold out to the present company, which completed it in the autumn of 1878. The Utah and Pleasant Valley Railroad Company and the Utah and Pleasant Valley Coal and Coke Company, which own the mines, are controlled by stockholders in New York.

The bed worked by this company dips about 3° NW. and outcrops in a ravine. The coal strata consist of 1 foot of clay, 9 feet of clean coal, and 18 inches of clay, and 2 feet of coal. These are underlaid and overlaid by a fine-grained buff sandstone. No faults have been found, but two dikes of metamorphic rock, from 8 to 10 feet wide and 20 feet apart, cut through the coal bed without faulting it. The coal shows scales of gypsum and of pyrite and occasional specks of resin. It is considered the best of the Utah coal as yet marketed in Salt Lake City. Several

a See Geol. Expl. 40th Par., Vol. III, page 473.

attempts have been made to coke it by native and imported burners, but, although a fair article is produced, none has yet been made that will bear the burden of the blast-furnace like the Pennsylvania coke, and only a small amount of it has been used by the Salt Lake smelters.

The mine is opened by a tunnel 576 feet long, running in coal the entire distance. The lateral drifts, or "cross-entries," only extend 220 feet. The system of working is by "pillars and stalls," each 18 feet wide, with rooms 150 feet in length. Only the 9-foot seam is worked. About one-sixth is slack. Thirty men were employed at the period under review. They were supplied by the company and received 80 cents per ton for mining the coal. The product during the census year was only 2,000 tons, but the mine will be regularly worked hereafter and the product greatly increased. The coal finds a market at Springville and the Mormon towns of Utah valley.

The other coal mines of importance in Pleasant valley are the Springville (7 feet), Mammoth (30 feet), and Pondtown (4 feet). The first two mentioned had shipped several hundred tons, but were idle at the period under review.

Fourteen miles south of Pleasant valley, near Connellsville, a 6-foot and an 11-foot bed were worked years ago by the Fairview Coal and Coke Company, and afterwards by the Utah Coal and Coke Company. It erected ten or fifteen coke ovens and made many hundred tons of coke, but the cost of transportation was very great, and in 1878 it failed after expending a large amount. Nothing had been done since.

SAN PETE COAL FIELD. (a)

The San Pete coal field is on the eastern slope of the Wasatch mountains and on the western side of the Sam Pitch valley, near Wales, 28 miles from Salt Creek station, on the Utah Southern railroad. Coal has been worked at this place in a small way since 1855. An English company, the Central Pacific Coal and Coke Company, owns 4,080 acres, together with small coke works comprising crusher, rollers, jigs, and nineteen coke ovens. The bed is 3½ feet thick and dips from 15° to 20° W. In each of two cañons, where erosion had exposed it, there are a tunnel and an incline, in all 550 feet of incline and 1,150 feet of tunnel. Very little coal has been extracted. Almost nothing has been done upon the mines for two years, the capital of the company having been expended in the construction of a narrow-gauge railroad to connect with the Utah Southern railroad at Salt Creek. At the period under review the road bed was ready for the ties, except a few bridges and culverts.

From the United States Mining Commissioner's report for 1875, page 357, the following is taken:

The coal is pronounced by H. S. Poole, F. R. S., Professor F. A. Genth, of the University of Pennsylvania, and Mr. Shone, of North Wales, to be bituminous.

Analyses by Professor F. A. Genth show the following percentages:

Moisture	1.16
Volatile matter	32.91
Fixed carbon	54.75
Ash	11.18
Sulphur	2.88

By H. S. Poole:

Volatile matter (including H_2O)	33.70
Fixed carbon	55.54
Ash	11.50
Percentage of coke	66.13

Dr. Genth says that "the coking qualities of this coal are not inferior to those of the best Pittsburgh coal, and the coke made of the same is apparently of excellent quality, and sufficiently dense to bear the burden of a blast-furnace."

CASTLE VALLEY COAL FIELD.

In the summer of 1873 Professor J. E. Clayton visited this region. From his report the writer has gathered the following:

This field is situated in Sevier county, near the eastern base of the Wasatch range, about 50 miles east of Salina, which is 140 miles south of Salt Lake City. The erosion of 3,000 or 4,000 feet of sandstone and shale from a great anticlinal fold by the headwaters of Dirty Devil river has exposed a coal series for an area of about 4 by 20 miles. The stratigraphical arrangement of the coal measures, beginning at the top, is as follows:

40 to 60 feet of coal. This bed has been burned out in an area of many square miles, and is still on fire.
40 to 60 feet of sandstone.
10 to 15 feet of alternate strata of coal and shale.
21 feet of clean coal.
20 to 30 feet of argillaceous matter.
5 to 8 feet of coal.

The lower bed is composed of a very hard compact coal, which, even when exposed for ages, shows very little tendency to slack. This coal gives only from 3½ to 4 per cent. of a very white ash, and shows no trace of sulphur. The 21-foot bed is not so hard as the former, but is still a good quality of coal.

Nothing has ever been done in this region aside from a number of locations made several years ago and allowed to lapse, and an equal number covering several thousand acres made in December, 1880.

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a This is said to belong to the Tertiary. See E. E. Howell, explorations west of 100th mer., 1875, Vol. III, page 278.

CEDAR CITY COAL MINES. (a)

A few miles south of Cedar City, Iron county, there is an elevated plateau. On its precipitous bluffs, and in the cañons where erosion has cut through many hundred feet of the upper sandstone strata, there are some important but little worked coal mines.

The Leyson mine was one of the first coal discoveries, having been worked at intervals in a small way by the Mormons since 1852. General Fremont visited it in 1853. In 1878 the Leyson brothers located 160 acres. The bed is 6½ miles east of Cedar City, and outcrops at the base of a precipitous sandstone bluff, 500 feet high, near the head of a short steep cañon. The coal series consists of six coal seams inclosed between strata of sandstone. They are in the following order, beginning at the top:

Sandstone.	
Clay	7 feet.
Coal	6 inches.
Clay	3 inches.
Coal	7 inches.
Clay	¾ inch.
Coal	8 inches.
Clay	½ inch.
Coal	4 inches.
Clay	1½ inches.
Coal	4½ feet.
Clay	2 inches.
Coal	2 feet.
Clay	15 inches.
Sandstone.	

Only the 4½-foot seam is worked. Shells are found in the clay over the coal, and also in a bed 2½ feet thick which outcrops for miles near the summit of the mountain. The bed dips about 2° NE., and is dry. The coal is a "brown coal" containing some gypsum, but no pyrites or resin. No analysis was obtainable. Some has been coked in rude ovens and worked well, but it was not known how it would stand in the blast-furnace. The mine is rudely developed by two inclines, 250 and 325 feet in length, and cross-drifts extending 900 feet. Pillars 10 feet square are left, and rooms are worked out from 18 to 30 feet wide. Three men are employed. Probably 5,000 tons have been extracted to date. Its market has been Cedar City, Pioche, and Silver Reef, respectively 6½, 110, and 45 miles distant. It is retailed in those places for $3 50, $35, and $15 per ton. The product in the census year was not over 300 tons.

In this region, but on the opposite side of the gorge, is the Walker mine. It is developed still less than the Leyson, and is apparently a portion of the same bed which has slipped from the plateau above and is much tilted and faulted. The are a dozen other coal prospects in the neighborhood, but only four of them could be dignified with the name of mines, even according to the above standard.

The Kanawha coal mine, or the Phœnix Coal and Coke Company's property, depending on the determination of the ownership, contains 960 acres, and is situated 9 miles south of Cedar City. It was discovered in 1873, and has been worked occasionally since. It is said that its outcrop can be traced several miles along the crescent-shaped bluff of an elevated plateau and a few hundred feet below the summit. Beginning at the top, the coal series is said to be made up approximately of the following strata:

Clay containing shells	5 feet.
Alternate small seams of clay and coal	7 feet.
Coal	2 feet 4 inches.
Clay	1 inch.
Coal	4 feet 6 inches.
Clay	1 inch.
Coal	1 foot.
Alternate seams of clay and coal	3 feet.

This bed has been worked to a very limited extent, having only 350 feet of openings. It is nearly level and is supposed to be far below the one found at Cedar City. The developments are not sufficient in extent to reach beyond the poor surface coal, and there has been no great demand for it. Perhaps 1,000 tons have been shipped.

In the Pahria country, Kane county, about 100 miles east of Silver Reef, beds of coal 20 feet thick are said to be exposed in several places on the cañon sides. With no roads and no market they are for the present of no economical importance, and are probably not even located.

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a See Explorations W. of the 100th Mer., Capt. G. W. Wheeler, 1875, Vol. III, page 278:

"The data collected indicate that the coal bed or beds of this region have extended, with but little, if any, interruption, from the western border of the plateau, near Cedar City and Kanara in Utah, to the Rio Grande in New Mexico, a distance of over 500 miles, * * * and belong to the Lower Cretaceous."

APPENDIX II.

INSTRUCTIONS TO EXPERTS, AND SCHEDULES.

APPENDIX II.—INSTRUCTIONS TO EXPERTS, AND SCHEDULES.

INSTRUCTIONS.

PURPOSE OF THE INVESTIGATION.

The purpose of the present inquiry is to elucidate, as far as practicable, the character, extent, and total influence of the mining industry. No industry has ever been examined throughout an extensive region so fundamentally and minutely as it is intended that the mineral industry of the West shall have been when this inquiry has been successfully accomplished. The results will be a great addition to the data of political economy, and will form a systematic accumulation of technical facts, such as does not at present exist.

The gathering of these data by the census agents will be a most honorable and a most instructive task; but it is also one requiring the exercise of energy, tact, and judgment. No effort must be spared to obtain full data in all cases. The good will of owners and superintendents is essential to the success of the inquiry, and the purposes of the investigation must be explained where necessary, in order that it may be apparent that it is planned in the interest of mining men throughout the country.

CAUTION.

I cannot impress too strongly or too often upon the agents that communications are to be regarded as inviolably confidential unless permission is given to mention them publicly. After each schedule is filled out, ask what data are to be regarded as confidential, and mark the answers so indicated with a "C". These answers will be used at the office solely for ascertaining averages and totals. Avoid even the *appearance* of using confidential communications, and remember that you are in honor bound to secrecy.

GENERAL REMARKS ON SCHEDULES.

Schedules and suggestions have been prepared for the agents as far as it is practicable to foresee from the office what will be called for in the field-work, but it is impossible to provide beforehand for the infinite number of combinations which may arise. Accordingly much is necessarily left to the intelligence and judgment of the agent, who, appreciating the spirit of the inquiry, should be able to draw up schedules for the many exceptional cases which will occur in conformity with the tone and scope of those ready prepared for him. Even in replying to the printed questions keen discernment will be called for. Ask yourself, in each case, what reply is *necessary* and *sufficient* to convey an exact comprehension of the fact.

SPECIMENS.

Specimens of ore, country rock, etc., are to be taken as directed in the schedules. The size of these specimens should be, as nearly as possible, 4 by 5 inches by from 1 inch to 1½ inches. Specimens of ore should be selected as characteristic, not as peculiarly rich or pretty. In many cases one specimen of ore and one of the country rock from each wall will suffice, but double the number may be taken when it seems necessary to illustrate the occurrence. Specimens should be well wrapped, and accompanied by an official label giving the precise locality and the position from which they have been taken. The label should be inclosed in the parcel, not pasted upon it.

USE OF THE MAILS.

When the agent has gathered the required information on the technical character of any mine or reduction works, he will immediately sign each schedule and number it with his own current number.

After noting the subjects and numbers of the schedules and specimens, he will mail them under frank to such address as the Director may order.

Specimens are also to be sent by mail. *Packages bearing the departmental frank are not limited to four pounds*, but it is desirable that they should not greatly exceed this weight.

All mail matter should be registered, and stamps will be furnished for the purpose.

PRINTED REPORTS OF COMPANIES, ETC.

At every property the agent will make a request for copies of annual or other reports issued by the company, and also for copies of any reports of experts which may have been printed. When any such are obtained, they will be mailed to the Director of the Geological Survey, or such office as he may direct. The agent will sometimes be referred to the town office of the company for such documents. In such cases he will write immediately to the secretary or other proper officer at the business office, requesting him to forward the desired papers. A note of these applications should be kept, in order that, if necessary, the request may be repeated.

ACCOUNTS.

In keeping his accounts the agent will be governed by the following rules:

1. All accounts accruing during any quarter should, if practicable, be adjusted and paid during the current quarter.

2. Vouchers should bear dates, and all receipts upon vouchers should bear the date at which they were paid.

3. The receipts upon vouchers should express the sums paid in words, written out in full, and by figures, and they should state the name of the bonded disbursing agent.

4. In all accounts for articles purchased, the date of each purchase, the quantity, and rate per unit of each article must be distinctly specified.

5. Subvouchers or bills are necessary, and should be appended to all vouchers when it is practicable to obtain them. When they cannot be obtained, a certificate to that effect should be added to the voucher.

6. All subvouchers must be made out in ink, and no item should appear on a subvoucher for which payment has not actually been made to the person whose name it bears, and when signed by an employé of the census are inadmissible.

7. When money is paid to a person unable to write his name, he must make his mark with his own hand, and the act should be witnessed by some other person than the disbursing officer.

8. Receipts for payments should, when practicable, be signed by a principal, not by an agent. When signed by an agent, he should sign his name in full, and the fact of his agency should be certified to by the person making the payment.

9. Treasury drafts or checks cannot be discounted at the expense of the government.

10. Accounts for services must give the dates, and it must be stated whether they are inclusive or not, and the rate of pay must be given.

11. Actual traveling expenses usual and essential to the ordinary comfort of travelers will be allowed, which will embrace the following items of expenditure only, viz: Cost actually paid for fares upon railroads (other than those bonded, over which transportation requests will be issued by the Superintendent of the Census), stages, steamboats, or other usual modes of conveyance, *i. e.*, street cars or omnibuses, or transfer coaches to and from depots and hotels, and when there are no such conveyances moderate and necessary hack hire, not exceeding legal rates, and baggage fees to porters. In the absence of public conveyances, wagons or saddle-animals may be hired. Sleeping-car fare will be allowed for one double berth for each person, or customary state-room accommodations on boats. When delays at hotels are incident to and necessary for the performance of the duties for which the traveler is ordered, charges for hotel expenses will be allowed not exceeding $4 per day, the bills for which should always be obtained and filed as subvouchers to the account, which should give the dates of arrival and departure and the rate per day. No charges will be allowed for hotel bills when the detention is unnecessary for the execution of the orders under which the journey is performed. Whenever special expenditures are made for meals, they will be allowed, but for no other items of refreshment than the ordinary food provided for travelers. Journeys will be made upon specific orders. The items authorized must appear in detail upon the voucher or memorandum attached thereto, together with subvouchers in all cases in which it is practicable. No other items, of whatever nature, will be allowed. The agent will make out at the end of each week, on official blanks with which he will be supplied, vouchers for his expenses, and a report showing the state of his funds and the work done during the week, and will immediately mail these documents to the officer to whom he is directly responsible. For his own protection the agent should keep duplicate copies.

METHODS OF INVESTIGATION.

Only in the case of mining and metallurgy is it possible to frame schedules of distinct questions, nor even in the case of these technical inquiries is it practicable to cover the whole ground by this method. In regard to the remaining subjects the agent will be guided by the topics presently to be mentioned, and will necessarily exercise his own judgment as to the best method of securing the desired information in particular localities.

When accurate data are unattainable on any topic, estimates must be substituted. Where such a course is unavoidable, great care should be taken to arrive at the best possible estimate under the circumstances, and the note should read: "Estimated at ....."

For convenience of reference a list of the printed schedules is given on the last page of these instructions.

MINING AND METALLURGY.

In order not to burden the returns with data as to mere prospects, agents will include as mines in the schedules under this chapter only such workings as are now being prosecuted and which have produced 50 tons and upward of remunerative ore, or which show a total length of shafts and galleries of 200 or more feet.

So far as the printed schedules go, the answers can be obtained, in great part, from the superintendent of the mine or mill. In some cases the agent will have to calculate the required answer from such data as he can obtain; in others he will need to make observations, take weighings, etc.

The schedules will often be found insufficient to cover particular cases. For example, in smelting works the treatment of intermediate products, such as dross from refining, matte or regulus, etc., varies with every establishment. Such matters are not to be neglected because they correspond to no printed questions. The agent must frame a schedule corresponding to the conditions and in general harmony with the printed questions, and fill it out in the same manner. Blank pages will be found at the end of the schedules for this purpose.

Some cases are not considered at all in the schedules, because they are rare or because practice is not sufficiently uniform in dealing with them. Suggestions will be made on a few such cases. For the rest the agent must provide by framing schedules for himself.

LIXIVIATION.

Leaching processes being closely allied to amalgamation, the agent will find it possible to use the greater part of the general questions on amalgamating mills in recording the data concerning lixiviation works, sometimes with the change of a word.

The leaching processes commonly consist of three steps: *First*, converting the metal into a soluble compound; *second*, leaching out the metallic compound; *third*, precipitating the metal. The first step is usually accomplished by a roasting process, and the agent is referred to the schedule on roasting furnaces. The methods of effecting solution and precipitation are so numerous that no general schedule can embrace them. The following topics are to be regarded as suggestions, to be supplemented and elaborated as may be required to embody the facts in a concise form:

Percentage of the metal rendered soluble.

Apparatus used in solution.

Manner of applying the solvent.

Method of preparing solvent.
Quantity of solvent and its dilution.
State whether the extraction is repeated, and how often.
If two or more solvents are employed, give the data for each.
Nature of the precipitant.
Quantity employed.
Apparatus used in precipitating.
Method of carrying out the precipitation.
Quality and character of the precipitate.
Method of cleansing the precipitate.
Method of dealing with residual fluid.

HAND WASHING AND "DRY WASHINGS"

Some of the points to be observed are:
Number of men in the district employed in this business.
Seasons of the year in which it is carried on.
Nationality of the washers.
Average earnings of washers.
Total amount of bullion recovered for the year from such washings.
Whether the ground worked is virgin or old.
Apparatus employed.

BOOMING AND SHOVEL-SLUICING.

These subjects are to be treated on the analogy of hydraulic mining.

RIVER WORKING.

River beds are worked (1) at low water, (2) by turning the channel, (3) by dredging or pumping the sands to the surface from a boat or floating platform, and perhaps in other ways. The agent will readily find in the schedules analogies for guidance in a record of ownership, cost, expenditure of labor, and the like, and in some cases for the treatment of the sands by sluicing, concentration, etc. A brief history of specially important enterprises of this description is desirable.

Besides mines of the metallic ores, the agent will visit all other deposits of useful minerals in his district which are actually being worked, such as quarries, banks, etc., of—

Building-stone.
Slate.
Mica.
Clay (fire clay, brick clay, potters' clay, kaolin).
Gypsum.
Phosphates.
Cement ("Roman," "Portland," etc.).
Sulphur.
Cryolite.
Barytes.
Strontia.
Asphalt and bitumen.
Borax.
Salt (rock-salt, salt pans, salt springs, salt flats, and the like).
Other sodium salts (carbonate, sulphate, etc.).

The establishments in which these substances are prepared for market also form a portion of the inquiry, in so far as the processes are essential to give the raw material a salable form. The eliquation or distillation of sulphur, the preparation of cement, and evaporation of saline waters are consequently included. The burning of brick is also to be regarded as essential to the sale of the clay, but the manufacture of pottery is excluded, as is also the manufacture of acid from sulphur, of alum from cryolite, and similar strictly manufacturing operations.

In investigating these deposits of useful minerals the schedule for mines will be used so far as it is directly applicable or can be made to apply by slight changes in phraseology to the case in hand, and all the topics there enumerated (position, ownership, etc.) are to be as minutely inquired into as in the case of metallic mines. Where it fails, the agent will embody the desired information in a concise form and in the general spirit of the detailed schedules.

Especial attention is to be given to the applicability of the raw material to the purposes for which it is employed in the arts. It is plain that the physical properties of building-stone, slate, and mica are of prime importance, whereas the value of sulphur, mineral manures, and sodium salts depends chiefly on their purity. Special processes and machinery too are evidently of great interest, as indicating the modification of mechanical methods induced by variations of material and of geological occurrence, and will receive due attention. Specimens will be collected with judgment and forwarded, like those of ores, duly labeled.

The following suggestions will be of use:

Building-stone and slate—

Geological horizon (give authority).
Structure of stone (whether massive, thick- or thin-bedded, jointed, etc.).
Angle of cleavage planes.
Sizes of blocks obtained.
Behavior in trimming.
Relative proportion of cutting stone, bridge stone, rubble, and waste.
Behavior on exposure (whether it crumbles, rusts, grows harder, etc.).
Any details as to chemical composition (analyses, if attainable, with name of chemist, whether there is pyrites in the rock, and as nearly as possible how much, and the like).

For what purposes the stone is employed.
The peculiar properties claimed for it.
Whether it takes a polish.
Strength (give details of any experiments that may have been made on its resistance to pressure).
Thinness and smoothness of slate.
Methods of working.
Machinery employed in extracting, hoisting, cutting, and the like.

Mica—

The average and maximum size of sheets, the clearness, and the like, are of importance.

Clay—

Binding properties.
Impurities (as iron, lime, etc.).
Color of burned product.
Ease with which clinker-brick are made.
Resistance to heat (for fire-brick) and tendency to "drop" or fall to pieces when exposed to changes of temperature.
Strength of brick.
Machinery.

Cement—

Binding properties.
Hydraulic properties.
Time of setting.
Hardness when set.
Resistance to chemical action (sewerage, etc.).
Machinery.

Bitumen and asphalt—

Binding properties.
Hardness.

With regard to the other valuable minerals mentioned, the main points to be suggested are the nature and amount of the foreign matters or impurities, their effects on the treatment and use of the raw material, and the apparatus and methods employed in bringing the latter into a salable condition.

CLARENCE KING,
Director United States Geological Survey,
Special Agent Census Office.

LIST OF SCHEDULES.

A. Metallic mines.
B. Coal mines.
C. Petroleum.
D. Charcoal-burning.
E. Hydraulic mines.
F. Hydraulic ditches.
G. Ore-dressing works.
H. Amalgamating mills.
I. Stamp batteries.
K. Pan amalgamation.
L. Roasting furnaces in amalgamating works.
M. Alternate amalgamation and concentration of battery-sands.
N. Alternate concentration and amalgamation of battery-sands.
O. Arrastras.
P. Smelting works in general.
P 1. Preliminary operations.
P 2. Smelting in shaft furnaces.
P 3. Smelting in reverberatory furnaces.
P 4. Desilverization by zinc.
P 5. Pattinsonizing.
P 6. Improving of lead.
P 7. Cupellation.
Q. Quicksilver reduction in general.
Q 1. Reduction in furnaces.
Q 2. Reduction in retorts.
Q 3. Quicksilver condensers.

SCHEDULE A.—METALLIC MINES.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

POSITION:
1. Topographical (considerable detail is required) .....
2. Position relatively to town .....
Position relatively to mills or works .....
3. Position relatively to lines of communication .....
4. Altitude referred to sea-level .....
Altitude referred to nearest important valley (give name) .....

OWNERSHIP:
5. Name of firm or company .....
Main office address .....
Capital stock .....
Number of shares .....
Par value .....
Quotation June 1, 1880 .....
Working capital .....
Name of superintendent .....
6. Dimensions and area of mining property .....
Nature of title .....
Date at which the property came into present ownership .....
7. Particulars of any outside real property of company (as wood-ranches, etc.)

GEOLOGICAL DATA:
8. Character of outcrop .....
Character of the deposit or ore-bearing formation (whether a vein, impregnation, bedded mass, etc.) .....
Dip and strike of ore-bearing formation .....
9. Dimensions of deposit so far as known .....
Occurrence of ore in the ore-bearing formation (*e. g.*, on the foot wall, in irregular lenticular bodies, etc.) .....

GEOLOGICAL DATA—continued.
10. Ore bodies, their size, distance below the surface, etc .....
What proportion of the ore-bearing formation has been productive? .....
11. Country rock, hanging wall, description (specimens) .....
Country rock, foot wall, description (specimens) .....
12. Fossils at or near mines (send specimens, with minute description of position, etc.) .....
13. Character of the country rock, hardness .....
Tendency to swell .....
Wet or dry (distinguish foot and hanging) .....
14. Faults in the vein (give amount and direction of displacement where possible) .....
15. Mineralogical character of the ore (specimens) .....
Physical character of ore .....
16. Nature of the gangue (specimens) .....
17. Quantity of water entering the mine per hour, in gallons (a) .....
Depth of the water level .....
Is there any notable change in the character of the ore at the water level?
18. Temperature at various depths .....

DEVELOPMENT:
19. Is the mine opened by tunnel, shaft, or incline? .....
Position of tunnel or shaft relatively to croppings .....
Dimensions of tunnels or shafts .....
20. Greatest depth of workings (vertical) .....
Greatest horizontal development of workings .....
Total length of shafts .....
Total length of galleries and tunnels .....
Total length of winzes .....
Customary grade of galleries .....

a One miner's inch may be taken at 700 gallons per hour.

SCHEDULE A.—METALLIC MINES—Continued.

SYSTEM OF WORKING:
21. Character of prospecting work (whether by galleries or drills)
Does prospecting form a regular part of the system of working?
Amount of prospecting and system pursued
22. Method of stoping (overhand, underhand, cross-cutting, etc.)
23. Minimum thickness of veins worked
Character of ground (swelling or not, etc.)
Proportion of galleries timbered
24. Whether power-drills are used
If so, state number used, their kind, and manufacturer
25. Kinds of powder used
Circumstances under which each is used
26. Mean volume of one ton of ore in place
Mean volume of one ton of ore broken
Weight and volume of a car-full of coal
Mean volume of a ton of waste in place
Mean volume of a ton of waste broken
27. Is underground transportation effected by men, animals, or machinery?
Give details as to number of men or animals, or system of machinery, as far as possible
28. Character and amount of dead work done during the year
Amount of waste raised during the year
Number of tons of water raised during the year
Mean depth from which ore has been raised during the year
Mean depth from which waste has been raised during the year
Mean depth from which water has been raised during the year

ACCIDENTS:
29. Number of men fatally injured during the year
Number of men disabled above one week

30. Cause of accidents.	Men killed.	Men injured.
Caving, fall of roof, etc		
Premature explosions of powder		
Falling of cages		
Overwinding		
Falls unconnected with hoisting machinery		
Other causes		

PLANT:
31. Hoisting-engines, number in use
Character (vertical or horizontal; whether coupled; with or without fly-wheel)
Dimensions of drum
Power of hoisting-engines
32. Pumping-engines, number, and number in use
Character and manufacturer
Power of pumping-engines
How much of the time does the pump ordinarily run?
Capacity per hour
33. Air-compressors, number, and number in use
Character and manufacturer
Power
Capacity
To what distance is air conveyed?
34. Other engines than those for hoisting, pumping, and compressing; their number, purposes, character, and power
35. Boilers, number, and number in use
Character and sizes
Style of grate
36. Hoisting-cables, wire or hemp
Flat or round
Size of cable
Average load hoisted, including cage
Average duration of a cable
Total number of tons hoisted on one cable
How often are cables inspected?
Are cables mended?
Height of sheaves above shaft
Diameter of sheaves
37. Is hoisting effected on cages, in buckets, or by skips?
Are safeties used to provide against falling?
Are safeties used to provide against overwinding?
If so, state system of safeties
Are pumps used? (if so, state kind)
And capacity per hour
If Cornish pumps, state length of rod
And number and weight of counterbalances
38. How are signals given (by bell, telegraph, or telephone)?
39. To what depth can operations be carried with the present plant?
For what interval of depth was the plant constructed?
Total cost of plant in place (including freight)

CONSUMPTION OF LABOR, POWER, AND MATERIAL:
40. Table of employés, wages, and shifts:

Employés.	Average number employed.	Length of shift.	Wages per shift.
Miners			
Surface workmen			
Foremen			

Number of staff (all employés not engaged in manual labor)
Aggregate salaries of staff per year
41. Is sinking, driving, stoping, or other work done on contract?
Explain system in detail
Equivalent of contract work in days' labor
42. Total number of hours' work done during the year (calculated as if done by one man)
Total amount paid on labor account (exclusive of staff) during the year
How many hours a day is the mine worked?
Total number of days on which the mine has been in active operation during the year
43. Total horse-power of engines
Total quantity of water-fed boilers during the year
Pressure of steam
Quantity of fuel burned under boilers and its character (if wood, ascertain weight per cord and kind of wood)
44. If fuel is used for other purposes, state them and the amount used
45. Table of supplies consumed, and their cost

Supplies.	Unit.	Quantity consumed during year.	Price per unit.	Total cost
Fuel	Cord			
	Ton			
Timber	Board feet			
Iron	Pounds			
Steel	Pounds			
Candles	Pounds			
Giant powder	Pounds			
Black powder	Pounds			
Other powder	Pounds			

46. Average cost of sinking shafts per foot (with dimensions)
Average cost of running drifts per foot (with dimensions)
Cost of mining per ton ore
Total cost of operations before the mine became productive

PRODUCTION:

47. Table of production.	Year ending May 31, 1880.	Month of June, 1879.	Month of June 1880.
Total number of tons produced during the			
Average assay contents in			
Average assay contents in			
Average assay contents in			

Minimum contents of ore extracted
Working results of treatment of ore
48. Production of former years, if attainable
Total production up to June 1, 1879
If silver is estimated in dollars, state whether the market value or mint value (1 oz. = $1.2929) is assumed

DISPOSITION OF ORE:
49. Mill or works at which the ore is treated
Do these mills or works belong to the mining company?
If the ore is sold, state average price per ton
Total received for ore during the year
50. Method of transporting ore to mill, works, or market
Cost of transportation per ton
Who pays for transportation?
51. Date of the commencement of mining operations
Date at which the mine first became productive

SCHEDULE B.—COAL MINES.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

POSITION:
1. Topographical (considerable detail is required)
2. Position relatively to town
Position relatively to mills or works
3. Position relatively to lines of communication
4. Altitude referred to sea-level
Altitude referred to nearest important valley (give name)

OWNERSHIP:
5. Name of firm and company
Main office address
Capital stock
Number of shares
Par value
Quotation June 1, 1880

OWNERSHIP—continued.
Working capital
Name of superintendent
6. Dimensions and area of mining property
Nature of title
Date at which the property came into present ownership
7. Particulars of any outside real property of company

GEOLOGICAL DATA:
8. Character of out-crop
9. Number and thickness of seams
10. Overlying rock, description (specimens)
Underlying rock, description (specimens)
11. Fossils in coal or country rock (send specimens, with minute description of position, etc.)
12. Shape and area of basin

SCHEDULE B.—COAL MINES—Continued.

GEOLOGICAL DATA—continued.
13. Faults and folds (give direction of main axis and amount of displacement of faults)
14. Character of coal (anthracite, bituminous, or lignite; coking, or non-coking)
15. Associated minerals (clay, iron-ore, pyrites, mineral resins, gypsum. A full reply)
16. Temperature of the mine at various depths
17. Whether the rock is wet or dry (distinguish roof and floor)
Quantity of water entering the mine per hour in gallons
What is the water level?
Is there any notable change at water level?

DEVELOPMENT:
18. Is the mine opened by tunnel, shaft, or incline?
Position of tunnel or shaft relatively to basin and croppings
Dimensions of tunnels or shafts
19. Greatest depth of workings (vertical)
Greatest horizontal development of workings
Total length of shafts
Total length of galleries and tunnels
Total length of winzes

SYSTEM OF WORKING:
20. Character of prospecting work (whether by galleries or drills)
Does prospecting form a regular part of the system of working?
Amount of prospecting and system pursued
21. System of working seams (by pillars and stalls, panel work, etc., described in detail)
22. Minimum thickness of seams worked
Proportion of coal left standing
Character of ground (swelling or not, etc.)
Proportion of galleries timbered
23. Occurrence of fire-damp
Occurrence of other gases
Use of safety-lamps
24. Whether coal-cutting machines are used
If so, state number used, their kind, and manufacturer
25. Kinds of powder employed
Circumstances under which each is used
26. Mean volume of one ton of coal in place
Mean volume of one ton of coal broken
Weight and volume of a mine car-load of coal
Weight of an empty car
27. Is underground transportation effected by men, animals, or machinery?. Give details as to number of men or animals, or system of machinery, as far as possible
28. Character and amount of dead work done during the year
Amount of waste raised during the year
Number of tons of water raised during the year
Mean depth from which coal has been raised during the year
Mean depth from which waste has been raised during the year
Mean depth from which water has been raised during the year

ACCIDENTS:
29. Number of men fatally injured during the year
Number of men disabled above one week

30. Cause of accidents.	Men killed.	Men injured.
Caving, fall of roof, etc		
Premature explosions of powder		
Explosions of gas		
Falling of cages		
Overwinding		
Falls unconnected with hoisting machinery		
Other causes		

PLANT:
31. Hoisting-engines, number, and number in use
Character (vertical or horizontal; whether coupled; with or without fly-wheel)
Dimensions of drum
Power of hoisting-engines
32. Pumping-engines, number, and number in use
Character and manufacturer
Power of pumping-engines
How much of the time does the pump ordinarily run?
Capacity per hour
33. Air-compressors, number, and number in use
Character and manufacturer
Power
Capacity
To what distance is air conveyed?
34. Other engines than those for hoisting, pumping, and compressing; their number, purposes, character, and power
35. Boilers, number, and number in use
Character and sizes
Style of grate
36. Hoisting-cables, wire or hemp
Flat or round
Size of cable
Average load hoisted, including cage or skip
Average duration of a cable
Total number of tons hoisted on one cable
How often are cables inspected?
Are cables mended?
Height of sheaves above shaft
Diameter of sheaves
37. Is hoisting effected on cages, in buckets, or by skips?
Are safeties used to provide against falling?
Are safeties used to provide against overwinding?
If so, state system of safeties

PLANT—continued.
38. Are pumps used?
If so, state kind
And capacity per hour
If Cornish pumps, state length of rod
If Cornish pumps, number and weight of counterbalances
39. How are signals given (by bell, telegraph, or telephone)?
40. To what depth can operations be carried with the present plant?
For what interval of depth was the plant designed?
Total cost of plant in place (including freight)

CONSUMPTION OF LABOR, POWER, AND MATERIAL:
41. Table of employés, wages, and shifts

	Average number employed.	Length of shift.	Wages per shift.
Miners			
Surface workmen			
Foremen			

Number of staff (all employés not engaged in manual labor)
Aggregate salaries of staff
42. Is sinking, driving, stoping, or other work done on contract?
If so, explain system in detail
Equivalent of contract work for the year in days' labor
43. Total number of hours' work done during the year (calculated as if done by one man)
Total sum paid on labor account (exclusive of staff) during the year
44. Total horse-power of engines
Total quantity of water-fed boilers during the year
Pressure of steam
Quantity of fuel burned under boilers, and its character
If fuel is used for other purposes, state them and the amount used
45. Table of supplies consumed, and their cost

Supplies.	Unit.	Quantity consumed during year.	Price per unit.	Total cost.
Fuel	Tons			
Timber	Board feet			
Iron	Pounds			
Steel	Pounds			
Candles	Pounds			
Giant powder	Pounds			
Black powder	Pounds			
Other powder	Pounds			

46. Average cost of sinking shafts per foot (with dimensions)
Average cost of running drifts per foot (with dimensions)
Cost of mining per ton coal
Total cost of operations before the mine became productive

PRODUCTION:
47. Table of production

	Year ending June 1, 1880.	Month of June, 1879.	Month of June, 1880.
Total number of tons produced in			

Proportion of slack produced
Production of former years, if attainable
Total production up to June 1, 1879
48. Principal purposes for which coal is used
Steam-raising power
Friability and behavior in drying

	Sulphur.	Moisture.	Ash.
49. Contents of coal in			

Give more complete analysis if possible
50. Average market price of coal at mine
Transportation facilities to markets

51. Principal markets.	Approximate quantities shipped.	Rate of freight.	Retail price at market.

52. Date of the commencement of mining operations
Date at which the mine first became productive

SCHEDULE C.—PETROLEUM.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

POSITION:
1. Topographical (considerable detail is required) .....
2. Position relatively to town .....
Position relatively to works .....
3. Position relatively to lines of communication .....
Altitude referred to sea-level .....
Altitude referred to nearest important valley (give name) .....

OWNERSHIP:
4. Name of firm or company .....
Main office address .....
Capital stock .....
Number of shares .....
Par value .....
Quotation June 1, 1880 .....
Working capital .....
Name of superintendent .....
5. Dimensions and area of oil property .....
Nature of title .....

GEOLOGICAL:
6. Describe cut-crop of oil-bearing rock, if any .....
If not, state how existence of oil was detected .....
7. Dip and strike of formation .....
Does it form a basin? If so, describe it, giving dimensions .....
Character of prevailing rocks (with specimens) .....
Fossils, if found here or in vicinity (send specimens and note position) ..
8. Give position and distance of nearest coal-beds .....
Character and thickness of rocks passed through (with specimens) .....
9. Observe temperature of well at various depths if possible .....

EXTENT OF DEVELOPMENT:
10. Depth of well .....
Is well flowing, or is oil pumped? .....

WORKING SYSTEM:
11. Method of boring generally used in district .....

WORKING SYSTEM—continued.
What machine was used for boring? .....
Diameter of hole bored .....
Rate of progress in different rocks passed through .....
Average cost of boring per running foot .....

ACCIDENTS:
12. Character and number of accidents during year .....

PLANT:
13. Character and number of engines employed .....
Horse-power (total) .....
Describe rest of plant .....
Total cost of plant (including freight) .....

CONSUMPTION OF LABOR, POWER, AND MATERIAL:
14. Average number of men employed, and capacities .....
Wages paid each .....
Total wages paid during year .....
15. Total horse-power of engines .....
Pressure of steam .....
Total quantity of water fed to boilers during year .....
Kind and quantity of fuel burned .....

PRODUCTION:
16. Total number of gallons oil produced during year ending June 1, 1880 ..
Total number of gallons oil produced during month of June, 1879 .....
Total number of gallons oil produced during month of June, 1880 .....
Production of former years, if obtainable .....
17. Character of oil produced and purposes for which used .....
Density of crude oil .....
Base after distillation (tar or paraffine) .....

DISPOSITION:
18. Value at well per gallon .....
Transportation facilities .....
Principal markets .....
Cost of freight thither per barrel and per gallon .....
Retail price there per gallon .....

SCHEDULE D.—CHARCOAL BURNING.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

POSITION:
1. Topographical position (considerable detail is required) .....
2. Position relatively to town .....
Position relatively to works or market .....
3. Position relatively to lines of communication .....

OWNERSHIP:
4. Name of owner .....
Working capital .....
Nature and area of wood claims .....
What proportion of available timber has been exhausted? .....
5. Date at which operations were begun .....
Date at which property came into present ownership .....
How long will supply of timber probably last at present rate of consumption? .....

WOOD:

6. Name and locality of ranch supplying wood.	Weight of wood per cord.	Botanical character.
.....	.....	.....
.....	.....	.....
.....	.....	.....

(Send section of bough and twig of foliage.)
7. Mean distance from which wood is transported .....
How is wood transported (by flume, wagon, or pack-animals)? .....
Cost of transportation .....
At what season is the wood cut? .....
Is the wood in the sap when cut? .....
Average length and thickness of billets of wood burning .....

PROCESS:
8. Is the wood charred in pits, stacks, or kilns? .....
How many of each in use? .....
Give reasons for preferring this system .....
9. Amount of wood charged in one apparatus, in cords .....
System of ignition .....
How is the combustion controlled? .....
Duration of burning .....
Duration of cooling .....
10. Are any distillation products preserved, and what? .....
Average number of bushels of charcoal produced per cord of wood .....
Weight of a bushel of charcoal .....
Maximum capacity of works .....

CONSUMPTION OF LABOR:

11. Class of laborers.	Number of each employed.	Wages of each per shift.	Length of shift.	Nationality.
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....

Total number of hours' labor performed during the year, calculated as if it had been done by one man .....

COST:
12. Total cost of plant .....
Cost of charring per bushel of charcoal .....
What portion of the wood is purchased? .....
At what price is it purchased? .....
What does wood felled by the owners cost, delivered, per cord? .....

PRODUCTION:

13. Amount of—	During year ending May 31, 1880.	During month of June, 1879.	During month of June, 1880.
Wood consumed, in cords	.....	.....	.....
Charcoal produced, in bushels	.....	.....	.....
Charcoal produced, in pounds	.....	.....	.....

DISPOSITION OF PRODUCT:
14. To what market is the charcoal shipped? .....
Cost of getting it to market .....
Is it sent in bulk or sacks? .....
How is it transported? .....
Average price at market .....

DESCRIPTION OF APPARATUS.
15. Give shape and dimensions of kilns, stacks, or pits, with diagram .....
16. If kilns, give—
Material of which constructed .....
Source from which material is obtained .....
Average duration .....
Cost of building .....
17. If stack or pit, give—
Time required for construction .....
Cost of construction .....
Material used for covering .....
18. Any other interesting details of apparatus .....

SCHEDULE E.—HYDRAULIC MINES.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

POSITION:
1. Topographical (considerable detail is required) .....
2. Position relatively to town .....
Position relatively to sources of supply of water .....
3. To lines of communication .....
4. Altitude referred to sea-level .....
Altitude referred to nearest valley available for tailings (give name) ....

OWNERSHIP:
5. Name of firm or company .....
Main office address .....
Capital stock .....

OWNERSHIP—continued.
Number of shares .....
Par value .....
Quotation June 1, 1880 .....
Working capital .....
Name of superintendent .....
6. Dimensions and area of mining property .....
Nature of title .....
Date at which property came into present ownership .....
7. Particulars of any outside real property of company (as land for tailings, etc. If the company also owns ditches, mention here, but describe on appropriate schedule) .....

SCHEDULE E.—HYDRAULIC MINES—Continued.

GEOLOGICAL DATA:
8. Superficial extent of the gravel deposit
Form of the surface
Form of the bed-rock (is it a river-bed or basin?)
Width and length of river-bed or basin
9. Maximum depth of gravel
Mean depth of gravel on claim
Do false bed-rocks occur in the deposit?
10. Kind and order of deposits recognized in gravel
11. What is the richest portion of the gravel?
Is any portion barren?
Is grass-root gold found?
What proportion of the gravel pays?
12. Surface of bed-rock (whether rough or not, etc.)
Character of bed-rock (description and specimen)
13. Are any fossils found in bed-rock or gravel (specimens, with minute description of occurrence)?
14. Is any portion of the gravel overlaid by lava (specimen)?
15. Occurrence of water and quick-sand
What is the water-level?
Is there any notable change in the deposit at the water-level?

DEVELOPMENT:
16. Is the claim opened by a tunnel or a cut?
How long is it?
What are its dimensions?
What is its grade?
Depth of chimneys from end of tunnel
Position of chimneys relatively to river-bed or basin
17. Area of gravel cleared away up to June 1, 1880

PIPING APPARATUS:
18. What is the difference of level between pressure boxes and nozzles?
Diameter of pipes and number
Material of which pipes are constructed
Method of joining lengths of pipe
Thickness of walls of pipe
Number of nozzles fed by one pipe
19. Total number of nozzles
Name of nozzle, and size
Maker of nozzle
Method of deflecting nozzle
Quantity of water thrown from nozzle (in gallons)
20. What definition of a "miner's inch" is accepted at this mine?
Mean length of stream thrown from nozzle

WATER SUPPLY:
21. From what locality does the water supply come (lake or river, etc.)?
Who owns the water?
If the water has been used before, state particulars

WORKING:
22. In how many benches is the mine worked?
What are the heights of the benches?
How much gravel is extracted by drifting?
What tenor of gravel pays for drifting?
23. Are power-drills in use? If so, state purposes, number, description of drill, etc
24. Kinds of powder used
State circumstances under which each is employed
What quantities of powder are used per blast?
25. System of disposing the powder
Is the blast tamped?
How is the blast fired?
If by electricity, state name and size of machine
How much ground is loosened on the average per cwt. of powder?
26. Are hurdy-gurdy wheels in use?
For what purposes, and how many?
Dimensions of wheels
How much water do the wheels consume?
What power do they develope?
27. Mean weight of a cubic yard of gravel

SLUICES:
28. Grade of sluices from bank to chimney
Length of sluices from bank to chimney
Is the chimney perpendicular, inclined, or in steps?
Description of pavement at bottom of chimney

SLUICES—continued.
29. Width of sluice-boxes in tunnel
Grade of sluice-boxes in tunnel
Length of sluice-boxes in tunnel
Style of riffles in sluice-boxes in tunnel
30. Sluice-boxes outside of tunnel, width
Sluice-boxes outside of tunnel, grade
Sluice-boxes outside of tunnel, length
Style of riffles in these sluices (state length for each style)
31. Number of under-currents
Number of drops, and their height
Number of grizzlies, and their height

AMALGAMATION:
32. How much quicksilver is added to the sluices, and where?
At what times is it added?
33. How is the gold found to be distributed in the sluices and under-currents?
How often are the various parts of the sluices cleaned up?
34. Describe the retorting of amalgam

ACCIDENTS:
35. Number of men fatally injured during the year
Number of men disabled above one week

Cause of accident.	Men killed.	Men injured.
Caving of bank		
Premature explosions of powder		

CONSUMPTION OF LABOR, POWER, AND MATERIAL:
36. What is the consumption of water per hour?
What is the consumption of water per day?
What is the consumption of water per year?
Under what head or pressure is the water used?
37. Number of men of different classes employed, and their wages
Length of shift
38. Number of hours' work done during the year, calculated as if done by one man
Number of working hours per day
Total amount paid on labor account
39. How much quicksilver is lost?
How much gold is supposed to be lost?
40. How long do riffles of various kinds last?
41. Total cost of plant
What is the total cost of hydraulic mining per ton of ore?
Total cost of operations before the mine became productive

PRODUCTION:
42. On how many days during the year has the mine been worked?
State usual limits of the season and the cause (ice or drought)

43.	Year ending June 1, 1880.	Month of June, 1879.	Month of June, 1880.
Quantity of gravel worked			
Quantity of gold obtained			

What is the fineness of the gold?
What other metal does the bullion contain?
Is any platinum found?
Are any diamonds found?
44. Production of former years, if attainable
Total production up to June 1, 1880

DISPOSITION OF BULLION:
45. To what market is the bullion shipped?
Through what transportation company?
What charges are incurred in getting it to market?
What discount is charged on the bullion?

SCHEDULE F.—HYDRAULIC DITCHES.

(Reported by ——— ———, No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

POSITION:
1. State sources of supply of water and their position
Does the water come from perennial springs or from melted snows?
Describe the country through which the ditches pass
2. Give the localities to which water is supplied and their relation to the ditches

OWNERSHIP:
3. Name of firm of company
Main office address
Capital stock
Number of shares
Par value
Quotation June 1, 1880
Working capital
Name of superintendent
Date at which the ditch was constructed
Date at which the ditch came into its present ownership

PLANT:
4. Reservoirs, their position and capacity
General description of construction
Total length of ditches (including flumes, pipes, etc.)
5. Length of flumes
Depth of cañons crossed
Length of pipes
Depth of cañons crossed
6. Grade of ditches
Cross-section of ditches

PLANT—continued.
Mean velocity of water in ditches at any section
Are the ditches lined to any extent?
If so, with what material?
7. Grade of flumes
Cross-section of flumes
Velocity of water in flumes
8. Diameter of pipes
Thickness of iron at various depths
How are longitudinal joints made?
How are circular joints made?
Are air-valves employed; and if so, at what points?

CAPACITY:
9. What is the total quantity of water delivered by the ditches?
What quantity of water is supposed to be lost by leakage?
What quantity of water is supposed to be lost by evaporation?
During what months is water supplied?
At what rates is water supplied?

COST:
10. What is the average cost of ditches per yard?
What is the average cost of flumes per yard?
What is the average cost of pipes per yard?
Cost of the reservoirs
Total cost of the whole plant
11. What repairs are made, and what do they cost?
12. State the different classes of employés, their number and wages
13. Give an account of the accidents which have occured during the year, their character and effects

SCHEDULE G.—ORE-DRESSING WORKS.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

POSITION:
1. Topographical (considerable detail is required)
2. Position relatively to town
Position relatively to mines
3. Position relatively to lines of communication

OWNERSHIP:
4. Name of firm or company
Main office address
Capital stock
Number of shares
Par value
Quotation June 1, 1880
Working capital
Name of superintendent
Date at which works were built
Date at which works came into present ownership

ORE TREATED:
5. Ore treated in the year ending June 1, 1880:

Name and locality of mines supplying ore.	Quantity of ore from each.	Assay value in various metals.			Character of ore.	
					Physical.	Mineralogical.

PROCESS:
6. State succinctly the following:
(1) Methods and apparatus employed for crushing
(2) For sizing
(3) For concentrating
(4) The succession of processes to which the ore is subjected
Capacity of the mill

CONSUMPTION OF LABOR, POWER, AND MATERIAL:
7. Table of employés, wages, and shifts

Classes of employés.	Number employed.	Wages per shift.	Length of shift.
Foremen			
Skilled workmen			
Helpers			
Laborers			

Number of staff (all employés not engaged in manual labor)
Aggregate salaries of staff
8. Total number of hours work done during the year, calculated as if done by one man
Total sum paid on labor account, exclusive of staff, during the year
How many hours per day is the mill at work?
Total number of days on which the works have been in operation during the year
9. Number of steam-engines and water-wheels
Horse-power of each

CONSUMPTION OF LABOR, POWER, AND MATERIAL—continued.
Total quantity of water-fed boilers during the year
Pressure of steam
Quantity of fuel burned under boilers, and its character (if wood, give weight per cord)
10. Quantity of water consumed in ore-dressing
Sources of water supply
State whether water is used repeatedly or only once
Quantity of lubricators consumed during the year

Cost of material.	Fuel per ton or cord.	Water per gallon.	Lubricators per gallon.
Price at works			

LOSSES:
11. Percentage of each metal escaping with tailings
Assay value of tailings

COST OF CONCENTRATION:
12. Cost of works
Cost of concentration per ton ore

TERMS FOR CUSTOM WORK:
13. Prices charged for concentrating per ton ore
Agreement, if any, as to quantity of concentrations returned, and their tenor
14. Do tailings or any valuable material become property of the ore-dressing works?
Terms on which ore is purchased, if any (if a sliding scale is in use, give it in full)
15. Who pays for the transportation of ore to the mill?
If the mill pays, at what rate?

PRODUCTION:

16.	Year ending June 1, 1880.	June, 1879.	June, 1880.
Ore treated during			
Concentrations obtained during			
Tenor of concentrations			

SAMPLING:
17. Describe system of sampling ore
Is the ore assayed in crucibles or scorifiers?
Are the assays corrected for loss in assaying?

DISPOSITION OF CONCENTRATIONS:
18. If the concentrations are sold, state where
How shipped to market?
Charges incurred in transportation
Average price received

DETAILS OF PROCESS:
19. The apparatus used in crushing, sizing, and concentrating is too various in character to admit of a detailed schedule. What is desired is as exact and detailed a description as possible, in which diagrams will be of great assistance. Most details can be brought under one or another of the following heads:
(1) Designation of apparatus, number of the kind, and number in actual operation.
(2) Construction and dimensions.
(3) Duty or amount of work performed.
(4) Method of handling or running.
(5) Disposition made of products.

SCHEDULE H.—AMALGAMATING MILLS.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

POSITION:
1. Topographical (considerable detail is required)
2. Position relatively to town
Position relatively to mines
3. Position relatively to lines of communication

OWNERSHIP:
4. Name of firm or company
Main office address
Capital stock
Number of shares
Par value
Quotation June 1, 1880
Working capital
Name of superintendent
Date at which mill was built
Date at which mill came into present ownership

ORE TREATED:
5. Ore treated in the year ending June 1, 1880:

Name and locality of mines supplying ore.	Quantity of ore from each.	Assay value in various metals.			Character of ore.	
					Physical	Mineralogical.

PROCESS:
6. Succinct description of process (*e. g.*, dry-crushing with 20 stamps, roasting in White's furnace with salt, pan amalgamation)
Capacity of mill
(If any centrifugal or other machine is used instead of a stamp-battery, frame a schedule for it similar to that for stamp-battery.)

CONSUMPTION OF LABOR, POWER, AND MATERIAL:
7. Table of employés, wages, and shifts

	Amalgamators.	Day-laborers.	Other workmen.	Foremen.
Average number employed				
Length of shift				
Wages per shift				

Number of staff (all employés not engaged in manual labor)
Aggregate salaries of staff
8. Total number of hours' work done during the year (calculated as if done by one man)
Total sum paid on labor account (exclusive of staff) during the year
How many hours a day is the mill at work?
Total number of days on which the mill has been in active operation during the year
9. Total horse-power of engines
Total quantity of water-fed boilers during the year
Pressure of steam
Quantity of fuel burned under boilers, and its character (if wood, give weight per cord)
10. Quantity of fuel consumed in retorting during the year

SCHEDULE H.—AMALGAMATING MILLS—Continued.

CONSUMPTION OF LABOR, POWER, AND MATERIAL—continued.
Quantity of fuel consumed in roasting during the year.....
If fuel is used for any other purposes state them, and the amount used..
11. Table of supplies consumed, and their cost .....

	Unit.	Total consumption for the year.	Price per unit.	Total cost.
Fuel	Cord or ton			
Quicksilver	Pounds			
Salt	Pounds			
Bluestone	Pounds			
Cast iron	Pounds			
Steel	Pounds			
Lubricators	Gallons			

LOSSES OF METALS:
12. Percentage of assay value of gold extracted by first treatment.....
Percentage of assay value of silver extracted by first treatment.....
Mean assay value of tailings in gold and silver.....
Mean assay value of slimes in gold and silver.....
COST OF MILLING:
13. Cost of mill (including freight).....
Cost of milling per ton ore.....
TERMS FOR CUSTOM MILLING:
14. Price charged for milling per ton ore.....
Agreement, if any, as to per cent. of bullion returned to mine owners....
Do slimes, tailings, and agitator sands belong to the mill? ....
15. Terms on which ore is purchased, if any. (If a sliding-scale is in use, give it in full).....
Who pays for the transportation of the ore to the mill? If the mill pays, at what rates?.....
Means of transportation .....

PRODUCTION:
16. Table of production during the year ending June 1, 1880.....

	Tons worked.	Mean assay value.		Bullion produced.	
		Fine gold.	Fine silver.	Fine gold.	Fine silver.
Ore					
Tailings					
Slimes					

(If the bullion product cannot be immediately given in fine metal the agent must calculate it from the other data) .....
Fineness of bullion in gold and in silver .....
What metal or metals constitute the residue?.....

17.	June, 1879.	June, 1880.
Ore slimes and tailings treated		
Fine gold extracted		
Fine silver extracted		

18. Production for former years, if attainable.....
Total production up to June 1, 1879 .....
If silver is estimated in dollars, state whether the market value or mint value (1 oz. = $1.2929) is assumed.....
DISPOSITION OF BULLION:
19. To what market is it shipped?.....
Through what transportation company .....
Charges incurred in getting bullion to market.....
Discount on bullion .....

SCHEDULE I.—STAMP-BATTERIES.

(Reported by ——— ———. No. —.)

Name: ——. State or Territory: ——. County: ——. District: ——.
CONSTRUCTION:
1. Crushing, wet or dry .....
Where was the battery manufactured, and by whom?.....
Number of stamps.....
Number of stamps per battery.....
2. Weight of stamps, new .....
Weight of shoe, new.....
Weight of die, new .....
Are the guides of wood, iron, or brass? .....
Are the shoes and dies of iron or steel?.....
Precise character of metal (*e. g.*, nearly white mottled iron, Franklinite, etc.).....
Number of cams per stamp .....
Maximum drop attainable .....
3. Width of mortar at the bottom of screen .....
Level of new die surface, measured from lower edge of discharge .....
Discharge, single or double .....
Kind of screen used (*e. g.*, needle-punched, brass wire, etc.; make special mention of concave screens, if used) .....
Number of screens (*e. g.*, No. 4 or No. 60) .....
Is the battery provided with a copper plate for amalgamation? .....
4. If a separate engine is used in running the battery, state its power.....
How many stamps are run by a single counter-shaft and pulley?.....
Is the battery fed by hand or machines? .....
If by machines, state name, manufacturer, and number .....
How many rock-breakers are used? .....
State name, manufacturer, and number.....
5. If the crushing is dry, state manner in which the ore is dried.....
If the mortar is built of plates, mention the fact, the general method of construction, and its success.....
ADJUSTMENT:
6. Mean fall of stamps:
Number of blows per minute.....
Order in which the stamps in each battery fall.....
Average rotation of stamps in rising.....
Average rotation of stamps in falling .....
DUTY OF BATTERY:
7. Mineralogical character of ore .....
Physical character (state hardness, toughness, etc., as exactly as possible) .....

DUTY OF BATTERY—continued.
8. Average number of tons ore crushed per day per stamp.....
Maximum amount of ore crushed per day per stamp .....
What weight of stamp and what drop gives the best result with these ores?.....
9. If battery amalgamation is practiced, state amount of gold caught .....
If battery amalgamation is practiced, state amount of silver caught .....
Proportion of each to contents of ore.....
How much gold and silver does battery amalgam contain per ounce? ....
WEAR AND CONSUMPTION:
10. How long do average cams last? .....
How long do average shoes last? .....
How long do average dies last?.....
How long do average screens last?.....
How long do average stems last?.....
What is the average weight of old shoes?.....
What is the average weight of old dies? .....
What is the usual fracture of cams? .....
11. Get or calculate the loss of weight of shoes and dies per ton ore crushed.
If battery amalgamation is practiced, state quantity of quicksilver added in the battery.....
If the battery crushes wet, state quantity of water per ton crushed (a) ..
Is the water clean, or pumped back from the settling tanks?.....
12. What is the shape of the surfaces of old shoes and dies? .....
Give depth of the depression or height of elevation of the center of each from the edge .....
METHOD OF HANDLING DRY-CRUSHED ORE:
13. State method of removing fine ore from front of screens .....
METHOD OF HANDLING PULP IN WET CRUSHING:
14. If crushing is wet, state minimum grade of sluices to settling tanks, and distances .....
Total area of settling tanks .....
Number of compartments .....
Area and depth of each .....
15. Number of compartments through which the pulp flows at any one time.
One stream passing through the settling tanks carries the pulp from how many stamps?.....
How deep is the pulp in a tank compartment when it is regarded as full?
How many tons of dry pulp does this represent? .....
16. What percentage of ore passes from the mill as slimes? .....
Area and depth of slime ponds.....

a One miner's inch may be taken as 700 gallons per hour.

SCHEDULE K.—PAN AMALGAMATION.

(Reported by ——— ———. No. —.)

Name: ——. State or Territory: ——. County: ——. District: ——.
EXTENT OF PLANT:
1. Number of pans for working ore .....
Number of settlers.....
Number of agitators.....
Number of clean-up pans.....
Number of tailings pans (for working concentrations from ore already once worked) .....
Number of hydraulic strainers.....
Number of quicksilver pumps .....
Number of retorts .....
Number of melting furnaces.....

PANS FOR WORKING ORE:
2. Dimensions of ore pans.....
System of ore pans .....
Name of maker, and place of manufacture.....
Number of shoes, and weight of set, new .....
Number of dies, and weight of set, new.....
What provisions are made for heating pans? ....
3. Customary number of revolutions per minute.....
Weight of charge, dry .....
Temperature ordinarily maintained.....
Is heating effected by live steam or exhaust steam? .....
How long does it take to work a charge?..... .....

SCHEDULE K.—PAN AMALGAMATION—Continued.

PANS FOR WORKING ORE—continued.
- Is the muller kept down all the time?
- If not, how long after the beginning of the charge is it raised?
4. How much quicksilver is charged to the pan?
- Is a certain amount of quicksilver charged per ounce of bullion in the ore?
- If not, what rule is adopted?
- At what period is the quicksilver added?
5. What other chemicals are added to each charge?
- In what quantities?
- At what period?
- What rule is adopted in adding chemicals?
6. Is iron added in shavings and the like?
- If salt is used, state source of supply
7. How much quicksilver is lost per ton of ore treated?
- What is the average weight of a set of worn-out shoes?
- What is the average weight of a set of worn-out dies?
- Calculate consumption of iron of shoes and dies per ton of ore
- Calculate consumption of iron shavings, etc., if used, per ton of ore
8. Has explosive gas ever been noticed in the pans? If so, state details
- Has the machinery ever been electrically charged? If so, state particulars in detail
9. How often are the pans cleaned up?
- Is there a general clean up of the mill?

SETTLERS:
10. Dimensions of settlers
- Customary number of revolutions per minute
- How long is a charge kept in the settler?
- How long after opening the highest plug is the settler completely emptied?

AMALGAM AND QUICKSILVER:
11. Is the quicksilver which passes through the strainers carried back to the pans in buckets, or pumped?
- Of what material are the straining bags?
- Is the amalgam from the straining bags put through a clean-up pan?
- If so, state dimensions and capacity
12. If an hydraulic strainer is used, state pressure
- If hot straining is employed, state system, temperature, and results
- What is the gold and silver contents of an ounce of amalgam as it goes to the retorts?

RETORTING:
13. Dimensions of retorts
- Is the vent at the center of the rear end or at the upper edge?
- If the former, is it the practice to turn the retorts after one side is worn?
- Is the section of the retort circular, and if not, of what shape?
14. What weight of amalgam is charged in a retort?
- How deep is the retort filled?
- Is the amalgam charged in cups?
- Or divided by disks of sheet-iron?
- How long does it take to retort a charge?
- How much fuel is burned?
15. Describe as nearly as possible the temperature
- How much quicksilver is lost in distillation?
- State whether the vent often chokes
- If so, to what cause is it ascribed?
- How many charges does the average retort stand?

RETORTING—continued.
16. Fineness of retorted bullion in gold
- Fineness of retorted bullion in silver
- How much copper does it contain?
- How much iron does it contain?
- How much lead does it contain?
- How much quicksilver does it contain?

MELTING:
17. General character and dimensions of furnace
- Size of pots, their material and maker
- Fluxes employed
- How much quicksilver does the bullion retain after melting?

AGITATORS:
18. Dimensions of agitators
- Number of revolutions per minute
- How much amalgam is recovered from agitators?
- What do agitator-sands assay?

TAILINGS:
19. What do the mill tailings, after leaving the agitator, assay?
- Are they concentrated?
- If on blankets, state total length of blanket sluices (not of compartments).
- Width of blankets
- By whom manufactured
- Number of compartments in each sluice
- Grade of blanket sluices
20. What quantity of concentrations is obtained?
- What do they assay?
- Quantity of gold and silver estimated as escaping from last sluice per ton of ore
21. Are the concentrations allowed to weather before retreatment?
- If so, how long?
- If they are otherwise treated (for instance roasted) state the method
22. What proportion of the assay value of the concentrations is recovered by reamalgamation?
- How does the pan amalgamation of concentrations differ from that of ore?
23. If the whole of the tailings is saved and treated, state the fact
- If the tailings are saved, but not treated, mention it

SLIMES: (a)
24. Area and depth of slime-basins
- What quantity of slimes is caught?
- What quantity of slimes is estimated as lost?
- Assay value of slimes
25. Are they treated at the mill or sold?
- If treated at the mill, state method or results
- If sold, state price paid
26. How many men have been salivated during the year?
- What is the average period of disablement?

SAMPLING AND ASSAYING:
27. Are samples of ore taken?
- If so, state how; how often, and what quantities
- Are battery samples taken—how, and how often?
- Are tailing samples taken—how, and how often?
28. State method of taking bullion samples, whether from melted or solid bullion; from what part of bar or pot, etc.
- Is the ore assayed in crucibles or scorifiers?
- Are ore assays corrected for loss in assaying?

a The amalgamation of slimes is sometimes performed in pans of peculiar construction, for instance, with several mullers. In such cases the agent will frame a schedule applicable to the case, and based on the scheme for ordinary pans.

SCHEDULE L.—ROASTING FURNACES (IN AMALGAMATING MILLS).

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

FURNACES:
1. Number of furnaces
- Number in use
- Name by which the furnace is known
- General system of furnace (as revolving cylinder, shaft-furnace, etc.)
2. Principal dimensions, with diagrams
3. Kind of lining and source from which it is obtained
- Any important details of construction
4. Does the ore pass through the furnace continuously, or is one charge finished before a second is begun?
- How often is the furnace shut down for repairs?
- What is the capacity of the furnace per twenty-four hours?
5. Method of conveying the ore to the furnace
- Method of feeding the ore into the furnace
- If any mechanism is used in feeding salt describe it

PROCESS:
6. Principal manipulations in roasting
- Describe, by colors, the temperatures used in roasting
7. Average tenor of the ore which is roasted, and any known details of composition
- Rule for mixing ores of different grades and qualities
8. If the ore is roasted charge by charge, what does the charge weigh?
- How long is a charge roasted?
- What is the interval of time between the charging of two successive charges?

PROCESS—continued.
9. If the ore is roasted continuously, how long is any particle of ore exposed to the roasting action?
10. Is salt used in roasting?
11. If so, what quantity per ton, on the average?
- Is the salt added with the raw ore, or when it is partially roasted, and if the latter, at what period?
- What governs the amount of salt added?
- What is the average sulphur contents of the ore roasted?
- How close is it necessary to keep to this sulphur contents?
- What is the average per cent. of metal chloridized?

LABOR, FUEL, AND POWER:
12. Number of men employed, and length of shifts
- What fuel is used?
- How much per ton of raw ore?
- If the furnace is a mechanical one, what is the power used to drive it?

RESULTS:
13. Loss of weight of ore in roasting
- Tenor of roasted ore, and any known details of composition

FLUE-DUST:
14. Number of flue-dust chambers
- Describe their general construction and dimensions, with diagram
15. Amount of flue-dust caught per ton of ore roasted
- Supposed loss of flue-dust
- Tenor of flue-dust
- Differences in composition between flue-dust and roasted ore

SCHEDULE M.—ALTERNATE AMALGAMATION AND CONCENTRATION OF BATTERY-SANDS (BEGINNING WITH AMALGAMATION).

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

AMALGAMATION OF PULP ON SLUICES:
1. Number of amalgamated battery sluices
- Slope of amalgamated battery sluices
- Width of amalgamated battery sluices
- Length of a sluice
- Quantity of bullion recovered from these sluices
- And its proportion to the metal contained in the ore

AMALGAMATION OF PULP ON SLUICES—continued.
2. If any other apparatus is employed in front of the battery, instead of amalgamated sluices, state particulars

CONCENTRATION OF TAILINGS FROM AMALGAMATED SLUICES:
3. State kind of concentrator
- Number of apparatuses
- Most important dimensions
- Quantity of pulp concentrated by one concentrator in twenty-four hours.

SCHEDULE M.—ALTERNATE AMALGAMATION AND CONCENTRATION OF BATTERY-SANDS, ETC.—Continued.

CONCENTRATION OF TAILINGS FROM AMALGAMATED SLUICES—continued.
If the sands, or a portion of them, are concentrated a second time, state the particulars
4. What quantity of concentrations is obtained per day and per ton ore crushed?
How are the concentrations treated (if by pan amalgamation use pan schedule)?
What do the concentrations assay?

TAILINGS FROM CONCENTRATORS:
5. How are the tailings from concentrators treated?
If further concentrated, state number and dimensions of apparatus
6. Quantity of concentrated tailings caught
Assay value of concentrated tailings caught

TAILINGS FROM CONCENTRATORS—continued.
What disposition is made of them?
If sold, state price
If chloridized for mill company, state rate
And per cent. of bullion returned

TAILINGS FROM PANS:
7. Quantity of pan residues obtained
Assay value
Disposition
If sold, state price
If chloridized for mill company, state rate
And per cent. of bullion returned

SCHEDULE N.—ALTERNATE CONCENTRATION AND AMALGAMATION OF BATTERY-SANDS (BEGINNING WITH CONCENTRATION).

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

CONCENTRATION OF PULP ON BLANKETS:
1. Number of blanket-sluices
Slope of blanket-sluices
Width of blanket-sluices
Length of a sluice
Number of blankets in a sluice
2. Frequency with which blankets are washed (discriminate blankets nearest battery, next lower, and so on)
Quantity of blanket concentrations obtained per ton ore crushed
Assay value of blanket concentrations

AMALGAMATION OF BLANKET CONCENTRATIONS:
3. Short description of amalgamator
Quantity of bullion recovered
Temperature of water
Quantity of water

TAILINGS FROM AMALGAMATOR:
4. If treated on amalgamated surfaces, state their nature
Is the copper of such surfaces silver-plated before amalgamation?
State length of surfaces
State breadth of surfaces
State slope of surfaces
Depth of water on plates
5. If any mechanism is employed as a substitute for a portion of the amalgamated sluices, state its nature and general dimensions
6. How long do plates last without reamalgamation?
If the copper plates are silver-plated, what does it cost per square foot?
How long does the plating last?
What quantity of material is caught on the foregoing sluices and substitutes?
What is its value by assay?

TAILINGS FROM BATTERY BLANKET-SLUICES:
7. What means are taken to extract the metal from blanket-sluice tailings?
If similar apparatus to that in use for amalgamator tailings is employed, state extent
Quantity of material caught
Value of this material by assay
8. If some different apparatus is used, state construction, dimensions, and results

TREATMENT OF MATERIAL COLLECTED FROM SLUICES, etc.:
9. State total quantity of material collected from sluices, etc
State assay value of material collected from sluices, etc
How is it treated?
If in pans, continue description on pan schedule.

TREATMENT OF TAILINGS ESCAPING FROM MILL SLUICES:
10. State general method of concentrating mill tailings:
Number and principal dimensions of apparatus
Quantity of concentrated tailings obtained
Assay value of concentrated tailings obtained
11. Disposition made of concentrations
If sold, state price
If worked for mill company in chloridising works, state price per ton paid for treatment
And per cent. of assay value returned by chloridization works

PAN TAILINGS:
12. Quantity of residues from pans obtained
Assay value
Disposition
If sold, state price
If chloridized for mill company, at what price?
And per cent. of bullion returned

SCHEDULE O.—ARRASTRAS.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

POSITION:
1. Topographical (considerable detail is required)
2. Position relatively to town
Position relatively to mines
3. Position relatively to lines of communication

OWNERSHIP:
4. Name of firm or owner
Address
Working capital
Name of superintendent
Date at which arrastras were built
Date at which they came into present ownership

ORE TREATED:
5. Ore treated during the year ending June 1, 1880

Name and locality of mines supplying ore.	Quantity [illegible]	Assay value in various metals.			Character of ore.	
					Physical.	Mineralogical.

PLANT:
6. Number of arrastras
Dimensions of arrastras, with diagrams
7. Describe paving (specimen)
Number and weight of drags
Of what rock are the drags (send specimen, unless the rock is the same as the paving)?

PLANT—continued.
8. Customary number of revolutions per minute
Weight of charge, dry
How long does it take to work a charge?
How much quicksilver is added per charge?
9. What rule is adopted to determine the quantity of quicksilver added, or what test is applied?
When is the quicksilver added?
10. What other chemicals are used?
In what quantities?
At what time are they added?
11. How are the arrastras discharged?
How often are the arrastras cleaned up?
12. Describe the straining of amalgam
What is the gold and silver contents of the amalgam as it goes to the retorts?
Describe the retorting
13. What disposition is made of tailings?
What is the supposed or known contents of tailings?
14. Describe the sampling done
How are assays made?

CONSUMPTION OF LABOR, POWER, AND MATERIAL:
15. Table of employés' wages and shifts

Classes of employés.			
Average number employed			
Length of shift			
Wages per shift			

Total number of hours work done during the year, calculated as if done by one man
Total sum paid on labor account during the year
16. During how many days of the year has the mill been in active operation?
How many hours a day is the mill in operation?
17. What is the motive power? (If animals, state number; if engine, state power)

SCHEDULE O.—ARRASTRAS—Continued.

CONSUMPTION OF LABOR, POWER, AND MATERIAL—continued.

18. Table of supplies consumed, and their cost.

	Unit.	Total consumption for the year.	Price per unit.	Total cost.
Fuel	Cord or ton			
Quicksilver	Pounds			
Salt	Pounds			
Bluestone	Pounds			
Lubricators	Gallons			

LOSSES OF METALS:

19. Percentage of assay value of gold extracted by first treatment
Percentage of assay value of silver extracted by first treatment
Assay value of tailings

COST OF MILLING:

20. Cost of plant
Cost of treatment per ton of ore

TERMS:

21. Terms on which ore is purchased
Terms on which ore is worked for owners

PRODUCTION:

22.	Year ending May 31, 1880.	Month of June, 1879.	Month of June, 1880.
Fine gold produced			
Fine silver produced			

Average fineness of bullion in gold and silver
Production of former years, if attainable

DISPOSITION OF BULLION:

23. To what market is the bullion shipped?
Through what transportation company?
Charges incurred in getting bullion to market
Discount on bullion

SCHEDULE P.—SMELTING WORKS.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

POSITION:

1. Topographical (considerable detail is required)
2. Position relatively to town
Position relatively to mines
3. Position relatively to lines of communication

OWNERSHIP:

4. Name of firm or company
Main office address
Capital stock
Number of shares
Par value
Quotation June 1, 1880
Name of superintendent
5. Date at which works were built
Date at which works came into present ownership
Amount of real estate owned

ORE TREATED:

6. Name and locality of mine supplying ore.	Quantity of ore from each mine for year.	Assay value of ore.			Character of ore.	
		In—	In—	In—	Physical.	Mineralogical.

COMPOSITION OF ORE:

7. Designation of ore.	Contents in—						
	Arsenic.	Antimony.	Sulphur.	Zinc.	Iron.	Lime.	Silica.

8. Who pays for transportation of ore to works?
If the smelting works, at what rate?

PROCESS:

9. Succinct description (*e. g.*, smelting in blast-furnaces with siliceous flux, and production of silver lead; desilverization by steam Pattinsonising; refining on tests)
11. Capacity of works
11. Is any royalty paid on patented processes or apparatus?
Amount paid
Name and concise description of process

CONSUMPTION OF LABOR, POWER, AND MATERIAL:

12. Class of laborers.	Number of each employed.	Wages of each per shift.	Length of shift.	Remarks.
Foremen				
Head smelters				
Helpers				
Day laborers				

CONSUMPTION OF LABOR, POWER, AND MATERIAL—continued.

Total number of hours' manual labor performed on wages during year (calculated as if it had been performed by one man)
Number of staff (all not employed in manual labor)
Aggregate salaries of staff per month
13. Style of blast-engine
Maker of blast-engine
Number of blast-engines in use
Size of blast-engines
Pressure of blast (average)
Volume of blast (average)
14. Horse-power of steam engine employed in running blast
Horse-power of other engines
Pressure of steam
Total quantity of water fed to boilers during year
Quantity and kind of fuel burned under boilers during year
If wood, ascertain weight per cord

15. Fuel consumed during year in—	Kind of fuel.	Quantity during year.	Weight per bushel.	Price at furnace.	Unit used.	Remarks.
Smelting						
Refining						
Roasting						
Other purposes						

16. Name and locality of mine supplying flux.	Quantity from each mine.	Price per ton at furnace.	Mineralogical character of flux.	Assay value, if any.

LOSSES OF METALS:

17. Percentages of assay values of metals extracted in smelting
18. Amount of flue-dust caught
Amount of metal contained in flue-dust
Amount of flue-dust supposed to be lost
How is flue-dust treated?
19. Quantity of matte formed per ton of ore
Percentage of metal in matte
Quantity of speiss formed per ton of ore

Loss in refining of	Lead.	Copper.	Silver.	Gold.
Percentage of assay value lost				

TERMS FOR CUSTOM WORK:

20. Charges for smelting ore per ton
Agreement, if any, as to per cent. of metal returned to mine
Do matte, flue-dust, and the like belong to the smelting works?
21. Terms on which ore is purchased (give sliding scale, if any is used)

COST:

22. Total cost of plant
Cost of smelting per ton of ore

SCHEDULE P.—SMELTING WORKS—Continued.

PRODUCTION:

22. Amounts worked or produced during—	No. tons of ore worked.	No. tons of crude metal extracted.	No. tons of crude metal refined.	No. ounces of fine gold produced.	No. ounces of fine silver produced.	No. — of refined metal produced.	
						Lead.	Copper.
Year ending June 1, 1880							
Month of June, 1879							
Month of June, 1880							

PRODUCTION—continued.

24. Assay value of—	In gold.	In silver.	In copper.	In lead.
Crude metal				
Matte				
Speiss				
Slag				

SAMPLING:
25. Describe system of sampling ore.
What assays are used?
Are assays corrected for loss in assaying?

DISPOSITION OF BULLION OR METAL:
26. To what market is it shipped?
Cost of getting it to market
Average price received at market
How is the metal sent to market (by what express, etc.)?

SCHEDULE P 1.—PRELIMINARY OPERATIONS.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

CRUSHING:
1. Kind of crushing machine used
Name of manufacturer
Size of machine
Number of machines

ROASTING:
2. Is roasting performed in heaps, stalls, kilns, or reverberatory furnaces?
Number of each
Number of each in actual operation
3. General dimensions of each
Any important details of construction (if furnaces, name and description)
Material and source of lining

ROASTING—continued.
4. Is ore roasted in charges or continuously?
If in charges, give weight of charge and time of roasting
Total capacity per 24 hours
How often are repairs needed in furnace?
Kind of fuel used in roasting
Amount of fuel used in roasting per ton of ore
Highest temperature to which ore is brought in roasting
5. Number of men employed per furnace
Number of men employed in roasting; total
If power is employed, state how much
If any substance is added to ore, state kind and quantity per ton ore
How complete is the roasting?
6. Method of conveying roasted ore to smelting furnace

SCHEDULE P 2.—SMELTING IN SHAFT-FURNACES.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.
1. Number of furnaces
Number in actual operation
Give diagrams of interior outline of vertical section and of interior outline of horizontal section at charging floor, with dimensions
2. What material is used for lining of furnace?
Whence obtained
Cost of lining
Average duration
3. Has the furnace an open hearth, or is it completely closed?
Is it provided with a siphon tap?
How many tuyeres per furnace?
Diameter of tuyeres
Of what metal are they made?
Are they water-cooled or not?
Are water-jackets employed?
4. Of what material is crucible built?
Mention any other interesting details of construction
What is the ordinary length of the run?
Do accretions form in the furnace?
Do they form at the bottom or top?
Is the furnace run with a bright top?
How often is the furnace barred out?
What amount of ore is smelted in 24 hours?
5. What kind of flux is used?
What does it cost per ton at furnace?
What amount is used per ton ore?
What kind of fuel is used?
What does it cost at the furnace?
What amount of fuel per ton ore?
If in bushels, weight of one bushel
Pressure of blast

6. Quantity produced per 24 hours of—	Number of tons.	Contents by assay.		
		In —	In —	In —
Metal				
Matte				
Speiss				
Slag				

7. Is the slag viscous or not?
Does it chill quickly or not?
8. Ascertain, if possible, the percentage in the slag
Of iron
Silica
Metallic oxides, etc.
9. Quality and characteristics of metal

SCHEDULE P 3.—SMELTING IN REVERBERATORY FURNACES.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.
1. Number of furnaces
Number of furnaces in actual operation
2. Give diagrams of horizontal section and of longitudinal section along center line, with dimensions
Height of stack
2. Of what material is hearth composed?
Of what material is roof composed?
Give source of lining and cost at furnace
Average duration of roof and hearth
Is the hearth supported on iron plates?
How often is it necessary to stop furnace for repairs?
4. What kind of flux is used?
What kind of fuel is used?

	Cost per unit.	Amount used per ton of ore.	Source from whence obtained.
Fuel			
Flux			

If fuel is reckoned in bushels, give weight of bushel
5. Quantity of ore per charge
Length of time required to work a charge

Production of—	No. tons produced per 24 hours.	Contents by assay.			
		In —	In —	In —	In —
Metal					
Matte					
Speiss					
Slag					

6. How is slag further treated?
Quality and characteristics of metal

SCHEDULE P 4.—DESILVERIZATION BY ZINC.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

1. Number of pots.
   Number in actual operation.
   Size of pots.
   Weight of furnace lead charged in a pot.
2. In how many portions is the zinc added?
   What is the weight of each?
   What is the rule according to which the quantity of zinc is determined?
3. Is the last trace of zinc removed from the market lead by steam, or by improving in a furnace?
   How much silver remains in the market lead?
   Give method of dealing with zinc-skimmings from furnace lead.
   How much rich lead is obtained per ton furnace lead?
   What percentage of silver does the rich lead contain?
   Are the zinc crusts treated by distillation or smelting?
4. If smelted, state size of furnace, and other details, as indicated in schedule for shaft smelting furnaces.
5. If distilled in retorts, give—
   (1.) Material of which retort is made.
   (2.) Total length of retort.
   (3.) Greatest width of retort.
   (4.) Weight of charge.
   (5.) Time required to distill a charge.
   (6.) Average duration of retort (in number of charges).
6. Give aggregate time consumed in separating a lot of furnace lead into market lead and rich lead.
   Give total quantity of fuel thus consumed per ton furnace lead.
   What is the total cost of labor involved in the separation?
   What is the average wages of men employed?

SCHEDULE P 5.—PATTINSONIZING.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

1. Give number of pots.
   Give number of pots in actual operation.
2. Give diagram showing disposition of plant, with measurements.
3. State system of crystallization (by thirds, by eighths, etc.)
4. How much rich lead is obtained on the average per ton furnace lead?
   What percentage of silver does rich lead contain?
   How much silver remains in the market lead?
5. What time is consumed in separating a lot of furnace lead into market lead and rich lead?
   How much fuel is consumed in separating a lot of furnace lead into market lead and rich lead?
   What is total cost of labor involved in the operation per ton of furnace lead?
   What wages do the men receive?
   How much fuel is consumed per ton lead separated?
   What is the total cost of process per ton furnace lead?
6. If steam is used (Luce & Rosan process), state pressure of steam.
   Describe superheating apparatus.

SCHEDULE P 6.—IMPROVING OF LEAD.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

1. Number of improving furnaces.
   Number of improving furnaces in actual operation.
   State general dimensions of furnaces with diagrams.
2. If the hearth is an iron pan, does it rest freely on supports?
   Is the pan cooled from beneath?
   What is the charge of furnace lead?
   Depth and area of melted charge.
3. At what temperature is it improved?
   What length of time is consumed in softening a charge?
   State kind of fuel and consumption per ton of furnace lead.
   What percentage of weight is lost in softening?
4. By what is it determined whether the lead is sufficiently improved?
   What disposition is made of the dross?
   What amount of labor is expended in refining?
   How long does a pan last?

SCHEDULE P 7.—CUPELLATION.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

1. Total number of furnaces.
   Number in actual operation.
   Are the furnaces of the English or German pattern?
2. If of English pattern, describe construction of test-frame, with dimensions.
   Give size of test.
   With what material is it lined?
   Is the test water-cooled?
   With what results?
3. Is the blast steam or air?
   What fuel is employed?
   How is the furnace-lead fed to the test?
   Is the refining completed on one test, or is the lead concentrated on one test and the refining completed on another?
4. If the latter method is employed, how far is the concentration carried?
   How many tons of lead can be treated on the average on one test?
   If the refining is divided, state for each.
   How much lead is treated per day in each furnace?
5. State fineness of bullion (gold and silver) produced.
6. Consumption of fuel per ton lead cupelled.
   Cost of labor per ton lead refined.
   Average wages of men.
   Loss in refining.
7. What disposition is made of the litharge?
8. Total cost of refining a ton of lead.
   What is the assay value of the poorest lead which could be refined without absolute loss in this locality?

SCHEDULE Q.—QUICKSILVER REDUCTION WORKS.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

POSITION:

1. Topographical (considerable detail is required).
2. Position relatively to town.
   Relatively to mines.
3. Position relatively to lines of communication.

OWNERSHIP:

4. Name of firm or company.
   Main office address.
   Capital stock.
   Number of shares.
   Par value.
   Quotation May 31, 1880.
   Working capital.
   Name of superintendent.
5. Date at which the works came into present ownership.
   Date at which the works were built.
   Amount of real estate owned.

ORE TREATED:

6. Name and locality of mine supplying ore.	Quantity of ore from each mine for year.	Assay value of ore.	Character of ore.	
			Physical.	Mineralogical.

7. Who pays for transportation of ore to works?
   If reduction works, at what rate?

SCHEDULE Q.—QUICKSILVER REDUCTION WORKS—Continued.

PROCESS:
8. Succinct description of process
9. Maximum capacity of works
10. Is any royalty paid on patented processes or apparatus?
Amount paid
Name and concise description of patented process

CONSUMPTION OF LABOR, POWER, AND MATERIAL:
11. Table of employés' wages and shifts

Class of laborers.	Number of each employed.	Wages of each per shift.	Length of shift.	Remarks.
Foreman				
Head smelters				
Helpers				
Day laborers				

Total number of hours' manual labor performed during the year, calculated as if it had been done by one man
12. Number of staff (all not employed in manual labor)
Aggregate salaries of staff per month
13. Style and material of suction blower
Maker of blower
Number of blowers in use
Sizes of blowers
Pressure of blast (average)
Volume of blast (average)
14. Horse-power of steam-engines employed in running blast
Horse-power of other engines
Pressure of steam
Total quantity of water fed to boilers during year
Quantity and kind of fuel burned under boilers during the year
If wood, ascertain weight per cord

CONSUMPTION OF LABOR, POWER, AND MATERIAL—continued.
15. Quantity of fuel consumed in quicksilver reduction during the year
16. If any flux is employed, state its character, source of supply, and price per ton at works

LOSSES OF METAL:
17. Percentage of quicksilver contents extracted
18. Amount of soot formed
Amount of metal contained in soot
19. If custom-work, give rates, with details
20. Terms on which ore is purchased

COST:
21. Total cost of plant
Cost of reduction per ton of ore

PRODUCTION:

22. Amount of—	During year ending June 1, 1880.	Month of June, 1879.	Month of June, 1880.
Ore worked (in tons)			
Quicksilver produced (in pounds)			

SAMPLING:
23. Describe system of sampling ore
What assays are used?
Are assays corrected for loss in assaying?

DISPOSITION OF PRODUCT:
24. To what market is quicksilver shipped?
Cost of getting it to market
Average price at market
What sort of flask is used?
How much quicksilver does a flask hold (average)?
How is the quicksilver sent to market?

SCHEDULE Q 1.—QUICKSILVER REDUCTION IN RETORTS.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.
1. Number of retorts
Diagrams, with dimensions of retorts
2. What is the weight of a retort?
How long does the average retort last?
What does a retort cost at the works?
Average quantity of ore treated in a retort per month
3. Average tenor of the ore
What flux is added?
How much per ton ore?
What is the weight of a charge of ore?
How long is it retorted?
Total interval between the beginnings of two successive charges
4. How much fuel is consumed per ton ore?
How much quicksilver does the burned ore contain?
What system of condensers is used (diagrams and dimensions)?
Percentage of quicksilver recovered
5. What men are employed?
Length of shift
Wages

SCHEDULE Q 2.—QUICKSILVER REDUCTION IN FURNACES.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.
1. Number of furnaces in the works
Number of furnaces described in this schedule
System of furnaces
Cost of furnaces
Are they designed to work continuously or intermittently?
Are they designed to work fine ore or lump ore?
2. Give diagrams of the furnace, with principal dimensions
Mention the materials used in lining, and their source
3. Any interesting details of construction
How long does the furnace last without repairs?
4. State the average quantity of ore treated in the furnace per month
What is the average tenor of the ore treated in the furnace?
What flux is added, if any?
And how much per ton of ore?
5. Is fuel charged with the ore?
If so, what fuel, and how much per ton of ore?
How much fuel is consumed per ton of ore roasted?
How much quicksilver does the burned ore contain?
6. If the furnace is intermittent, state the weight of a charge.
How long is it roasted?
Total interval of time between two charges
7. If the furnace is continuous, state the time during which any piece of ore is exposed to roasting action
8. If adobes are made, state how much of the ore is so treated
What cement is used in making adobes?
Of what size are the adobes?
How long are the adobes dried?
9. What men are employed at the furnace?
Length of shift
Wages

SCHEDULE Q 3.—QUICKSILVER CONDENSERS.

(Reported by ——— ———. No. —.)

Name: ———. State or Territory: ———. County: ———. District: ———.

1. Name by which the condenser is known.	Material of which it is constructed.	Cost of a condenser.	Number in use.	Cubic capacity.	
				Each.	Total.
Total					

Total length of path traversed by fume

2. Any interesting details of construction
3. If iron condensers are used, state what portion of the walls is most rapidly corroded
4. If masonry condensers are employed, what measures are taken to prevent percolation of metal?
How much quicksilver is it estimated that a cubic foot of masonry absorbs?
5. Give as many details as possible of the amounts of quicksilver caught in the different condensers
What is the temperature of the fumes escaping from the last condenser?
6. Quantity of soot obtained (if possible per ton ore)
Character and contents of soot
Method of treating soot
7. Is draught produced by chimney or suction blower?
If by a chimney, how much of the time is a fire kept burning at the base?
If by a blower, state name of manufacturer and size

APPENDIX III.

DIRECTORY OF DEEP MINES, AMALGAMATING MILLS, ARRASTRAS, SMELTING WORKS, PLACER MINES, AND DITCHES.

APPENDIX III.—DIRECTORY.

[1880.]

DEEP MINES.

ALABAMA.

Name of claim.	District.	County.	Name of claim.	District.	County.
Houston & Pinson		Cleburne.	Riddle	Township 19	Talladega.

ARIZONA.

Alaska	Oro Blanco	Pima.	Flora Temple	Castle Dome	Yuma.
Alta	Owens	Mohave.	Fontenoy	Hualapai	Mohave.
American Flag	Maynard	Do.	Fresno	do	Do.
Anchor	Silver	Yuma.	Friend	Silver	Yuma.
Antelope	Maynard	Mohave.	Galena Chief	Castle Dome	Do.
Arkansaw	Castle Dome	Yuma.	General Lee	Cedar Valley	Mohave.
Arnold	Cedar Valley	Mohave.	Gillett	Harshaw	Pima.
Atlanta	Myers	Pima.	Golden Eagle	Globe	Pinal.
Baden	Hualapai	Mohave.	Grand Central	Tombstone	Pima.
Billy Engle	Cedar Valley	Do.	Grand Dipper	do	Do.
Black and Tan	Hualapai	Do.	Great Eastern	Silver	Yuma.
Black Rock	Silver	Yuma.	Gunsight	Cedar Valley	Mohave.
Blue Bells	Hualapai	Mohave.	Do	Myers	Pima.
Bonton	Harshaw	Pima.	Hackberry	30 miles east of Mineral Park	Mohave.
Bradshaw	Tombstone	Do.	Hackberry South	do	Do.
Bronze	Eureka	Yuma.	Hamburg	Silver	Yuma.
Buell	Hualapai	Mohave.	Head Centre	Tombstone	Pima.
Buena Vista	Eureka	Yuma.	Helena	Castle Dome	Yuma.
Bull Dog	Silver	Do.	Hermosa	Harshaw	Pima.
Bullion	Hualapai	Mohave.	Hibernia	Cedar Valley	Mohave.
Bunker Hill	Cedar Valley	Do.	Holland	Harshaw	Pima.
Burro	Silver	Yuma.	Hope	Cedar Valley	Mohave.
Cady or June	Hualapai	Mohave.	Hopkins	Castle Dome	Yuma.
Caledonia	Castle Dome	Yuma.	Indian Boy	Hualapai	Mohave.
Do	Silver	Do.	Irene	Globe	Pinal.
Cerbat	Hualapai	Mohave.	Iron Cap	Silver	Yuma.
Champion	do	Do.	Ironclad	do	Do.
Cherum	do	Do.	Ithaca	Hualapai	Mohave.
Chief of Dome	Castle Dome	Yuma.	I X L	do	Do.
Cincinnati	Hualapai	Mohave.	Do	Harshaw	Pima.
Clara	Silver	Yuma.	Josephine	Silver	Yuma.
Colorado	do	Do.	Juniper	Dos Cabezas	Pima.
Congress	Cedar Valley	Mohave.	Kanawha Belle	Hualapai	Mohave.
Conner	Hualapai	Do.	Keystone	do	Do.
Consolidated Arizona	Arivaca	Pima.	La Plata	Globe	Maricopa.
Contention	Tombstone	Do.	Last Hope	Silver	Yuma.
Copper Chief	Montezuma	Yuma.	Little Chap	Harshaw	Pima.
Copper King	do	Do.	Little Chief	Hualapai	Mohave.
Crescent	Myers	Pima.	Little Dome	Castle Dome	Yuma.
Do	Near Mineral Park	Mohave.	Little Willie	do	Do.
Crystal Spar	Castle Dome	Yuma.	Lone Star	Hualapai	Mohave.
Cupel	Hualapai	Mohave.	Longarina	Oro Blanco	Pima.
Dean	Maynard	Do.	Lost	Silver	Yuma.
Defiance	Turquoise	Pima.	Lula	do	Do.
Diamond	Harshaw	Do.	MacCormick	Globe	Pinal.
Dolly Varden	Hualapai	Mohave.	Mack Morris	do	Maricopa.
Douglass	Castle Dome	Yuma.	Mamie	Tombstone	Pima.
Eastern	Myers	Pima.	Mammoth	Swisshelm	Do.
Echo	Montezuma	Yuma.	Do	Cherry Creek	Yavapai.
Edward Everest	Hualapai	Mohave.	Mandeville	Silver	Yuma.
El Capitan	Near Pioneer	Pinal.	Margarita	Eureka	Do.
Elkhorn	Montezuma	Yuma.	Mariposa	Maynard	Mohave.
Emerald	Tombstone	Pima.	Mary Ann	Silver	Yuma.
Emma	Silver	Yuma.	Mayflower	Hualapai	Mohave.
Empire	do	Do.	Maliese	Silver	Yuma.
Do	Hualapai	Mohave.	Merrimac	Tombstone	Pima.
Do	Tombstone	Pima.	Metallic Accident	Hualapai	Mohave.
Engineer	Silver	Yuma.	Mexican	Globe	Maricopa.
Esperanza	Pima	Pima.	Miller	Castle Dome	Yuma.
Eugenia	Cedar Valley	Mohave.	Mineral Bed	Myers	Pima.
Excelsior	Silver	Yuma.	Miner's Hope	Hualapai	Mohave.
Fagan	Harshaw	Pima.	Mississippi	Maynard	Do.
Fairfield	Hualapai	Mohave.	Mocking Bird	Hualapai	Do.
Flagstaff	do	Do.	Monitor	Tombstone	Pima.
Flora	do	Do.	Montana	Oro Blanco	Do.

DEEP MINES—Continued.

ARIZONA—Continued.

Name of claim.	District.	County.
Montezuma	Montezuma	Yuma.
Monumental	Myers	Pima.
Morality	Harshaw	Do.
Morning Star	Myers	Do.
Mountain Side	Silver	Yuma.
Mountain View	Harshaw	Pima.
Murphy	Dos Cabezas	Do.
Nellie Kenyon	Silver	Yuma.
Norfolk	do	Do.
Norma	Castle Dome	Do.
North Star	Silver	Do.
Northern Pacific	Oro Blanco	Pima.
Oriental	Hualapai	Mohave.
Oro	Ellsworth	Yuma.
Oro Plata	Hualapai	Mohave.
Overland	do	Do.
Pacific	Silver	Yuma.
Palmetto	Owens	Mohave.
Paymaster	Hualapai	Do.
Peabody	30 miles east of Mineral Park	Do.
Peck	Peck	Yavapai.
Pinkeye	Hualapai	Mohave.
Pocahontas	Castle Dome	Yuma.
Prince	Silver	Do.
Princess	do	Do.
Prince George	Hualapai	Mohave.
Pure Metal	do	Do.
Quaker	do	Do.
Queen	Swissholm	Pima.
Quick Relief	Hualapai	Mohave.
Railroad	Castle Dome	Yuma.
Rainbow	Cedar Valley	Mohave
Rattlesnake	Tombstone	Pima.
Do	Silver	Yuma.
Red Cloud	do	Do.
Red Doe	Myers	Pima.
Red Jacket	Silver	Yuma.
Red Top	Tombstone	Pima.
Revolution	Harshaw	Do.
Richmond West	Globe	Maricopa.
Rooster	Silver	Yuma.
Rosano	Eureka	Do.
Rover	Silver	Do.
Salvador	Harshaw	Pima.
San Xavier	Pima	Do.
Schenectady	Hualapai	Mohave.
Schuylkill	do	Do.
Scotia	Harshaw	Pima.
Senator	Owens	Mohave.
Setting Sun	Hualapai	Do.
Shenandoah	do	Do.
Signal	Owens	Mohave.
Silver Belt	Big Bug	Yavapai.
Silver Brick	Silver	Yuma.
Silver City	do	Do.
Silver Era	Globe	Pinal.
Silver Girt	Myers	Pima.
Silver Glance	Silver	Yuma.
Silver Hill	Hualapai	Mohave.
Silver King	Pioneer	Pinal.
Silver Monster	Hualapai	Mohave.
Silver Nugget	Globe	Maricopa.
Silver Prince	Peck	Yavapai.
Silver Queen	Cedar Valley	Mohave.
Sixty-three	Hualapai	Do.
Snowflake	do	Do.
South Dome	Castle Dome	Yuma.
South King	Harshaw	Pima.
Spruce	Montezuma	Yuma.
Starks & Ewing	Hualapai	Mohave.
Stein Crusoe	Silver	Yuma.
Stockton	Hualapai	Mohave.
Stonewall	Globe	Maricopa.
Do	Tombstone	Pima.
Sulphuret	do	Do.
Sunrise	Hualapai	Mohave.
Sunset	Tombstone	Pima.
Surpriser	Pioneer	Pinal.
Tiger	Hualapai	Mohave.
Do	Tiger	Yavapai.
Tigress	Hualapai	Mohave.
Tioga	Tombstone	Pima.
Tip Top	Humbug	Yavapai.
Toughnut Extension	Tombstone	Pima.
Toughnut & Goodenough	do	Do.
Triangle	Harshaw	Do.
True Blue	Tombstone	Do.
Undine	Harshaw	Do.
Vanderbilt	Hualapai	Mohave.
Vulture	In town of Vulture	Maricopa.
Waco	Silver	Yuma.
Wander	do	Do.
Warsaw	Oro Blanco	Pima.
W. C. Davis	Harshaw	Do.
Westward	Myers	Do.
Whale	Swissholm	Do.
William Penn	Castle Dome	Yuma.
Wilmington	Silver	Do.
Winchester	Hualapai	Mohave.
Wisconsin	Harshaw	Pima.
Woodchoppers' Relief	Hualapai	Mohave.
Yuma Chief	Silver	Yuma.

CALIFORNIA.

Addenda	Bodie	Mono.
Adelaide	Robinson's Ferry	Calaveras.
Afterthought	Furnaceville	Shasta.
Alabama	Jamestown	Tuolumne.
Amelia	Washington	Calaveras.
Antelope	Banner	San Diego.
Apex	French Gulch	Shasta.
App	Jamestown	Tuolumne.
Ballychoop	Ballychoop	Trinity.
Baltimore	Lee	Inyo.
Bandin	Mokelumne Hill	Calaveras.
Banghart	Whisky Creek	Shasta.
Banner	Mokelumne Hill	Calaveras.
Bechtel Consolidated	Bodie	Mono.
Belmont	Cerro Gordo	Inyo.
Belvidere	Bodie	Mono.
Black Bear	South Fork Salmon	Siskiyou.
Do	Deadwood	Trinity.
Black Hawk	Bodie	Mono.
Blind Lode	Oro Fino	Siskiyou.
Blue Hill	Banner	San Diego.
Bodie Bluff Consolidated	Bodie	Mono.
Bodie Consolidated	do	Do.
Bodie Tunnel	do	Do.
Booker Consolidated	do	Do.
Borago Bronco	Beverage	Inyo.
Boston Consolidated	Bodie	Mono.
Branch Mint	Coso	Inyo.
Brown Bear	Deadwood	Trinity.
Brown Monster	Russ	Inyo.
Brush Hill	Hayden Hill	Lassen.
Bulwer Consolidated	Bodie	Mono.
Cactus	Lee	Inyo.
Cargo Muchacho	Cargo Muchacho	San Diego.
Carrol	Quartz Valley	Siskiyou.
Centennial	Lee	Inyo.
Do	French Gulch	Shasta.
Central	Ballychoop	Trinity.
Champion	Bodie	Mono.
Do	Independence	Calaveras.
Chance	Pittsburgh	Shasta.
Chaparral	Near Kelsey	El Dorado.
Do	Banner	San Diego.
Chicago	Mokelumne Hill	Calaveras.
Christmas Gift	Coso	Inyo.
Cinderella	Deep Spring Valley	Do.
Coe	Coulterville	Mariposa.
Cold Spring	French Gulch	Shasta.
Colossus	Union	Inyo.
Commanche	Blind Spring	Mono.
Consolidated Amador	Sutter Creek	Amador.
Confidence	Coso	Inyo.
Do	Confidence	Tuolumne.
Consolidated Pacific	Bodie	Mono.
Consolidated Wyoming	Nevada City	Nevada.
Creekside	White Peak	Mono.
Crowning Glory	Cerro Gordo	Inyo.
Custer	Coso	Do.
Deadwood	Willow Creek	Nevada.
Defiance	Coso	Inyo.
Do	Bodie	Mono.
Diana	Blind Spring	Do.
Dividend	White Peak	Do.
Dolan & Cogswell	Near Angel's	Calaveras.
Downs	Volcano	Amador.
Dudley	Bodie	Mono.
Duncan	Oro Fino	Siskiyou.
Dunlap	Silverado	Los Angeles.
Emma	Picacho	San Diego.
Empire	Plymouth	Amador.
Do	Virginia Bar	Siskiyou.
Eureka	Blind Spring	Mono.
Excelsior	Ballychoop	Trinity.
Extra	Pittsburgh	Shasta.
Ferguson	Mariposa Estate	Mariposa.
Fletcher	Oro Fino	Siskiyou.
Fogus	Volcano	Amador.
Franklin	French Gulch	Shasta.
Fraud	Picacho	San Diego.
Fresno Enterprise	Potter Ridge	Fresno.
Genesee Valley	Genesee Valley	Plumas.
Glencoe Consolidated	Mokelumne Hill	Calaveras.
Gold Stripe	Indian Valley	Plumas.
Golden Chariot	Banner	San Diego.
Golden Eagle	Hayden Hill	Lassen.
Golden Fleece	Picacho	San Diego.
Golden Gate	Volcano	Amador.
Do	Sonora	Tuolumne.
Golden Thread	Beverage	Inyo.
Golden Wreath	Fish Springs	Do.
Good Promise	Picacho	San Diego.
Goodshaw	Bodie	Mono.
Gracewood	Cerro Gordo	Inyo.
Great Western	White Peak	Mono.
Green Gulch	Mariposa Estate	Mariposa.
Green Monster	Union	Inyo.
Green Mountain	Indian Valley	Plumas.
Gwin	Mokelumne Hill	Calaveras.

DEEP MINES—Continued.

CALIFORNIA—Continued.

Name of claim.	District.	County.
Harrington	Bodie	Mono.
Harris	Jamestown	Tuolumne.
Hayden	Julian	San Diego.
Helenger	Pittsburgh	Shasta.
Helvetia	Julian	San Diego.
Hemlock	Panamint	Inyo.
Heslep	Jamestown	Tuolumne.
Hidden Treasure	Picacho	San Diego.
Highland	French Gulch	Shasta.
Hite	Mariposa Estate	Mariposa.
Holmes	Mokelumne Hill	Calaveras.
Homer	Homer	Mono.
Homestake	Picacho	San Diego.
Honeycomb	French Gulch	Shasta.
Howard	Quartz Valley	Siskiyou.
Hubbard	Banner	San Diego.
Ida Easly	Calistoga	Napa.
Idaho	Grass Valley	Nevada.
Ignacio	Cerro Gordo	Inyo.
Illinois	Indian	Mono.
Indian	Swansea	Inyo.
Indiana	do	Do.
Ishena	Furnaceville	Shasta.
Ivanpah Consolidated	Clark	San Bernardino.
Jennie June	Pittsburgh	Shasta.
Johnson	Quartz Valley	Siskiyou.
Josephine	Coso	Inyo.
Do	Mariposa Estate	Mariposa.
Jupiter	Bodie	Mono.
Kearsarge	Kearsarge	Inyo.
Kelty	Riverside	Tuolumne.
Kentuck	Banner	San Diego.
Kerrick	Blind Spring	Mono.
Keynot	Beverage	Inyo.
Keystone Consolidated	Amador City	Amador.
Keystone	Picacho	San Diego.
Klamath	Sawyer's Bar	Siskiyou.
Knickerbocker	Union	Inyo.
Knox & Osborne	Mokelumne Hill	Calaveras.
Last Chance	Picacho	San Diego.
Do	Quartz Valley	Siskiyou.
Laura	Blind Spring	Mono.
Lizzie Bullock	Clark	San Bernardino.
Lone Star	Hayden Hill	Lassen.
Lookout	Coso	Inyo.
Louie	Picacho	San Diego.
Louisiana	Cherokee	Tuolumne.
Lost Confidence	Whisky Creek	Shasta.
Lucky Jim	Coso	Inyo.
Lyford	Blind Spring	Mono.
Madeira	Volcano	Amador.
Madden	Banner	San Diego.
Mad Ox	Whisky Creek	Shasta.
Madre	Cargo Muchacho	San Diego.
Mammoth	Ballychoop	Trinity.
Mariposa	Coso	Inyo.
Mariposa Tunnel	Mariposa Estate	Mariposa.
Maryland	Bodie	Mono.
Mayboll	Picacho	San Diego.
May Lundy	Homer	Mono.
McClinton	Bodie	Do.
McNulty	Placerville	Eldorado.
Mellones or Stanislaus	Robinson's Ferry	Calaveras.
Mexican	Mariposa Estate	Mariposa.
Minietta Belle	Lookout	Inyo.
Modoc	do	Do.
Do	Blind Spring	Mono.
Monitor Consolidated	Indian Valley	Plumas.
Monte Christo	Deadwood	Trinity.
Monte Richard	Jackson	Amador.
Montezuma	Deadwood	Trinity.
Morgan	Carson Hill	Calaveras.
Mount Ophir	Mariposa Estate	Mariposa.
Murchie	Nevada City	Nevada.
Neal	Indian	Mono.
Nevada City	Nevada City	Nevada.
New Albany	Summerville	Tuolumne.
New York Hill	Grass Valley	Nevada.
Niagara	French Gulch	Shasta.
Noonday	Bodie	Mono.
Northern Light	Pittsburgh	Shasta.
Northern Wedge	Picacho	San Diego.
North Extension of Boston	Mokelumne Hill	Calaveras.
North Noonday	Bodie	Mono.
North Star	Picacho	San Diego.
Occidental	Ballychoop	Trinity.
Old Coso	Coso	Inyo.
Oneida	Jackson	Amador.
Original Amador	Amador City	Do.
Oro	Bodie	Mono.
Oro Fino	Union	Inyo.
Owens	Julian	San Diego.
Padre	Cargo Muchacho	Do.
Pacific	Plymouth	Amador.
Peter Gass	Mokelumne Hill	Calaveras.
Phil. Sheridan	Picacho	San Diego.
Phœnix	Coso	Inyo.
Do	Silverado	Los Angeles.
Picacho	Picacho	San Diego.
Piute	Piute	Mono.
Placerville	Placerville	El Dorado.
Plumas Eureka	Quartz Township	Plumas.
Plumas National	Indian Valley	Do.
Pool	Hornitos	Mariposa.
Potter	Pittsburgh	Shasta.
Principal	Picacho	San Diego.
Providence	Nevada City	Nevada.
Queen Bee	Bodie	Mono.
Rattlesnake	Ballychoop	Trinity.
Ready Relief	Banner	San Diego.
Do	Picacho	Do.
Red Bluff	Ballychoop	Trinity.
Redman	Banner	San Diego.
Reliance	Picacho	Do.
Reserve	do	Do.
Rex Montis	Kearsarge	Inyo.
Rising Sun	Colfax	Placer.
Riverside	Riverside	Tuolumne.
Rocky Bar	Grass Valley	Nevada.
Rose	Placerville	El Dorado.
San Diego	Julian	San Diego.
San Lucas	Cerro Gordo	Inyo.
Savercool	Seneca	Plumas.
Scorpion	French Gulch	Shasta.
Scout	Deep Spring Valley	Inyo.
Sibyl	French Gulch	Shasta.
Silver Glance	White Peak	Mono.
Soulsby	Soulsbyville	Tuolumne.
South Bodie	Bodie	Mono.
South Bulwer	do	Do.
South Hite	Mariposa Estate	Mariposa.
South Noonday	Bodie	Mono.
South Star	Picacho	San Diego.
South Standard	Bodie	Mono.
Southern Cross	Picacho	San Diego.
Southern Wedge	do	Do.
Springfield	Springfield	El Dorado.
Standard Consolidated	Bodie	Bodie
Stonewall	Banner	San Diego.
Sucredo	Mariposa Estate	Mariposa.
Sultan Hill	Indian	Mono.
Summit	Blind Spring	Do.
Syndicate	Bodie	Do.
Tellurium	Pine Grove	Amador.
Tilden	Picacho	San Diego.
Tioga Consolidated	Bodie	Mono.
Tompkins	Quartz Valley	Siskiyou.
Tower	Indian	Mono.
Trade Dollar	Deep Spring Valley	Inyo.
Triangle	Picacho	San Diego.
True Augar	Ballychoop	Trinity.
True Gold	Placerville	El Dorado.
Union Consolidated	Cerro Gordo	Inyo.
University	Bodie	Mono.
Valentine	Mokelumne Hill	Calaveras.
Do	Lee	Inyo.
Vance	Mokelumne Hill	Calaveras.
Volunteer	Quartz Valley	Siskiyou.
Washington	Lee	Inyo.
Do	Hornitos	Mariposa.
Do	Julian	San Diego.
Do	French Gulch	Shasta.
Whisky Slide	Mokelumne Hill	Calaveras.
Widdekind	Cerro Gordo	Inyo.
Wild Rose	Clover Patch	Mono.
Williams	Pittsburgh	Shasta.
Wright & Miller	Oro Fino	Siskiyou.
Wyoming	Panamint	Inyo.
Yellow Jacket	South Fork Salmon	Siskiyou.
Yosemite	Hornitos	Mariposa.
Do	French Gulch	Shasta.
Zelle	Jackson	Amador.

COLORADO.

Adelaide	California	Lake.
Adelphi	Eureka	San Juan.
Agassiz	California	Lake.
Alabama	Uncompahgre	San Juan.
Alaska	do	Do.
Albro	Morris	Clear Creek.
Alexander	do	Do.
Alta	Upper San Miguel	Ouray.
American	Gold Hill	Boulder.
American Flag	Nevada	Gilpin.
Amie	California	Lake.
Annie Wood	Uncompahgre	San Juan.
Argentine	California	Lake.
Aspen	Animas	San Juan.
Bald Mountain	Tin Cup	Gunnison.
Bagola	Uncompahgre	Ouray.
Belcher	Animas	San Juan.
Belden	Battle Mountain	Summit.
Belle of the West	Lake	Hinsdale.
Bobtail	Gregory	Gilpin.
Bonanza	Uncompahgre	San Juan.
Bonanza Tunnel	Animas	Do.
Bors	Quartz Valley	Gilpin.
Boston	Uncompahgre	San Juan.
Breece Iron	California	Lake.
Bull Domingo	Hardscrabble	Custer.
California	Nevada	Gilpin.
Do	Galena	Hinsdale.

DEEP MINES—Continued.

COLORADO—Continued.

Name of claim.	District.	County.
Caribou Consolidated	Grand Island	Boulder.
Cashier	Gregory	Gilpin.
Catalpa	California	Lake.
Centennial	Gregory	Gilpin.
Champion	Idaho	Clear Creek.
Chrysolite	California	Lake.
Chameeron	Upper San Miguel	Ouray.
Cleveland	Animas	San Juan.
Clifford	York	Clear Creek.
Climax	California	Lake.
Colorado Central Consolidated	Griffith	Clear Creek.
Colorado Prince	California	Lake.
Cold Spring	Gold Hill	Boulder.
Colorado Springs	Buckskin	Park.
Colorado Ter. National	Griffith and Queens	Clear Creek.
Columbia	Eureka	San Juan.
Columbus	Monarch	Chaffee.
Comstock	California	La Plata.
Consolifiated Hercules and Roe	Griffith	Clear Creek.
Congress	Mosquito	Park.
Cyclops	Enterprise and Mountain House.	Gilpin.
Dexter	Uncompahgre	Ouray.
Diamond Tunnel	Griffith	Clear Creek.
Do	Animas	San Juan.
Dolly Varden	Consolidated Montgomery	Park.
Dominion	Spanish Bar	Clear Creek.
Donaldson	Trail Run	Do.
Donna Juniata	Spanish Bar	Do.
Double Decker	California	Lake.
Dunderberg	Griffith	Clear Creek.
Dunkin	California	Lake.
Dyer	do	Do.
Eagle	Morris	Clear Creek.
Eagle Bird	Bald Mountain	Summit.
Egyptian	Nevada	Gilpin.
Emancipation	Gold Hill	Boulder.
Emerson	Sugar Loaf	Do.
Empire	Animas	San Juan.
Empress	Gregory	Gilpin.
Equator	Griffith	Clear Creek.
Evening Star	California	Lake.
Fairmount-Shafter	Spanish Bar	Clear Creek.
Fanny	Enterprise and Mountain House.	Gilpin.
Fanny Barrett	Mosquito	Park.
First National	Banner	Clear Creek.
Florence	California	Lake.
Forest Queen	Ruby	Gunnison.
Fred Rogers	Upper Union	Clear Creek.
Free Gold	Free Gold	Chaffee.
Freeland	Spanish Bar	Clear Creek.
Gem	Idaho	Do.
German	Gregory	Gilpin.
Glass-Pendery	California	Lake.
Gold King	Upper San Miguel	Ouray.
Golden Age	Central	Boulder.
Golden Gate	Uncompahgre	Ouray.
Grand View	Pioneer	Do.
Do	Uncompahgre	Do.
Gray Copper	Sugar Loaf	Boulder.
Gray Eagle	Hardscrabble	Custer.
Do	Animas	San Juan.
Great Republican	Chicago	Clear Creek.
Gunnell	Eureka	Gilpin.
Hard Money	Hawkeye	Do.
Haseltine	Russell	Do.
Helen	Bevan	Summit.
Hercules	Animas	San Juan.
Hibernia	California	Lake.
Hidden Treasure	Nevada	Gilpin.
Highland Chief	California	Lake.
Highland Mary	Animas	San Juan.
Highlander	Idaho	Clear Creek.
Homestake	Homestake	Lake.
Hoosier and Goldsmith Maid	Gold Hill	Boulder.
Hope	Pioneer	Ouray.
Horsefall	Grand Island	Boulder.
Hortense	Chalk Creek	Chaffee.
Hudson	Idaho	Clear Creek.
Hukill	Spanish Bar	Do.
Humboldt	Near town of Realta	Custer.
Idaho	Grand Island	Boulder.
Idaho Tunnel	Idaho	Clear Creek.
Inez	Hinsdale	Park.
Iron	California	Lake.
Jennie Parks	Animas	San Juan.
Joe Reynolds	Montana	Clear Creek.
John Jay	Central	Boulder.
Jones	Nevada	Gilpin.
Junction	Griffith	Clear Creek.
Kansas	Nevada	Gilpin.
Do	Mosquito	Park.
Kansas Lode	Nevada	Gilpin.
Kent County	do	Do.
Kismet	Magnolia	Boulder.
La Crosse	Nevada	Gilpin.
Lee	Virginia	Clear Creek.
Leviathan	California	Lake.
Leadville Consolidated	do	Do.
Leavenworth	Russell	Gilpin.
Lebanon	Griffith	Clear Creek.
Lincoln	Gold Hill	Boulder.
Little Annie	Summit	Rio Grande.
Little Chief	California	Lake.
Little Pittsburgh	do	Do.
Long and Derry	California	Lake.
London	Mosquito	Park.
Mackey	Iowa	Clear Creek.
Maid of the West	Uncompahgre	San Juan.
Mammoth	do	Do.
Mary Murphy	Chalk Creek	Chaffee.
Mastodon	Eureka	San Juan.
Matchless	California	Lake.
Maud Monroe	Spanish Bar	Clear Creek.
Mayflower	do	Do.
Melvina	Gold Hill	Boulder.
Meyer Consolidated	California	Lake.
Miner Boy	do	Do.
Minnie	Gregory	Gilpin.
Missouri	Russell	Do.
Molas	Animas	San Juan.
Monarch	Monarch	Chaffee.
Montezuma	Iron Springs	Ouray.
Morning Star	California	Lake.
Mountain Chief	Gold Hill	Boulder.
Mountain Lion	Magnolia	Do.
Mountain Monarch	Third	Huerfano.
Murray	Montana	Clear Creek.
Muscovite	Cascade	Do.
Naperville	McKay	Summit.
Nathan	Banner	Clear Creek.
Native Silver	Grand Island	Boulder.
Neith	Upper Union	Clear Creek.
Nelson	Ward	Boulder.
Nettie	Iron Springs	Ouray.
Nevada	do	Do.
Newman	Pioneer	Do.
New York and Colorado	Gregory	Gilpin.
Niwot	Ward	Boulder.
North Star	Animas	San Juan.
North Star No. 2	do	Do.
N. W. H., jr	Upper San Miguel	Ouray.
Ocean Wave	Galena	Hinsdale.
Ohio Consolidated	do	Do.
Osceola	Iron Springs	Ouray.
Palmetto	Galena	Hinsdale.
Palmyra	Upper San Miguel	Ouray.
Pandora and Oriental	do	Do.
Parson	Iron Springs	Do.
Patten	Idaho	Clear Creek.
Peerless	Horseshoe	Park.
Pewabic	Russell	Gilpin.
Philadelphia	Animas	San Juan.
Pike	Iron Springs	Ouray.
Pioneer	Upper Union	Clear Creek.
Do	Consolidated Ten Mile	Summit.
Plata Verde	Hardscrabble	Custer.
Poorman	Grand Island	Boulder.
Potosi	Sneffles	Ouray.
Powers	Russell	Gilpin.
Pride of the West	Animas	San Juan.
Prussian	Gold Hill	Boulder.
Pyrenees	Nevada	Gilpin.
Ralls County	do	Do.
Red Cloud	Uncompahgre	San Juan.
Red Elephant	Downieville	Clear Creek.
Red Rogers	Uncompahgre	San Juan.
Riverside	do	Ouray.
Robert E. Lee	California	Lake.
Robinson Consolidated	Consolidated Ten Mile	Summit.
Russia	Consolidated Montgomery	Park.
Sacramento	Sacramento	Do.
Saxon	Uncompahgre	San Juan.
Sayr Burroughs	Nevada	Gilpin.
Seven-thirty	Grand Island	Boulder.
Silver Cliff	Hardscrabble	Custer.
Silver Cord	Galena	Hinsdale.
Silver Dollar	Russell	Gilpin.
Silver Wave	California	Lake.
Sioux City	Eureka	San Juan.
Slide	Gold Hill	Boulder.
Smith	Gregory	Gilpin.
Smuggler	Central	Boulder.
Do	Upper San Miguel	Ouray.
Songbird	Hardscrabble	Custer.
South American	Cascade	Clear Creek.
Specie Payment	Virginia	Do.
Stevens	Argentine	Do.
Sunshine	Idaho	Do.
Summit	Upper San Miguel	Ouray.
Terrible	Hardscrabble	Custer.
Do	Sneffles	Ouray.
Tom Moore	Eureka	San Juan.
Toronto	Mountain House	Gilpin.
Tribune	Eureka	San Juan.
Trojan	Grand Island	Boulder.
Tropic	Seaton	Clear Creek.
Ulay and Ute	Galena	Hinsdale.
Union	Uncompahgre	Ouray.
United Gregory	Gregory	Gilpin.
United States Depository	Sneffles	Ouray.
Vanclusc	Sugar Loaf	Boulder.
Valley View	Iron Springs	Ouray.
Verde	Verde	Custer.
Victor	Idaho	Clear Creek.
Victoria	Gold Hill	Boulder.
Virginia	California	Lake.
Virginius	Sneffles	Ouray.
Wain	Gregory	Gilpin.
West Flack	Nevada	Do.
What Cheer	Iron Springs	Ouray.

DEEP MINES—Continued.

COLORADO—Continued.

Name of claim.	District.	County.	Name of claim.	District.	County.
White Cloud	Virginia	Clear Creek.	Wheel of Fortune	Consolidated Ten Mile	Summit.
White Pilgrim	Gold Hill	Boulder.	Wyandotte	Russell	Gilpin.
White Quail	Consolidated Ten Mile	Summit.	Yankee Boy	Snettes	Ouray.
Wheel of Fortune	Snettes	Ouray.	Yellow Pine	Sugar Loaf	Boulder.

DAKOTA.

Alta	Rockford	Pennington.	Highland	Whitewood	Lawrence.
Atlantic	Custer	Custer.	High Lode	do	Do.
Badger	Whitewood	Lawrence.	Homestake	do	Do.
Black Tail	do	Do.	Hoodoo	Bear Butte	Do.
Caledonia	do	Do.	Keystone	do	Do.
California	Rockford	Pennington.	King Solomon	Newton Forks	Pennington.
Carter	Bear Butte	Lawrence.	Lonalla	Whitewood	Lawrence.
Champion	Whitewood	Do.	Mammoth	Custer	Custer.
Clermont	Bear Butte	Do.	Merrit No. 2	Bear Butte	Lawrence.
Cross	Cross	Pennington.	Old Bill	Custer	Custer.
David City Lightning	Cole	Custer.	Old Charlie	do	Do.
Deadwood	Whitewood	Lawrence.	Oro Cache	Whitewood	Lawrence.
El Refugio	Bear Butte	Do.	Oro Fino	Bear Butte	Do.
Escondido	do	Do.	Peoche	Whitewood	Do.
Esmeralda	Whitewood	Do.	Penobscot	Cole	Custer.
Evangeline	Rockford	Pennington.	Portland	Whitewood	Lawrence.
Fairview	Whitewood	Lawrence.	Queen Bee	Newton Forks	Pennington.
Father de Smet	Lost Placer	Do.	Quincy	Cross	Do.
Flora Belle	Whitewood	Do.	Rich	Bear Butte	Lawrence.
Florence	Bear Butte	Do.	Royal Bengal Tiger	Newton Forks	Pennington.
Giant and Old Abe	Whitewood	Do.	Savage	Whitewood	Lawrence.
Golden Gate	Lost Placer	Do.	Scandinavian	do	Do.
Golden Terra	Whitewood	Do.	Sir Roderick Dhu	do	Do.
Gold Finch	do	Do.	Sitting Bull	Bear Butte	Do.
Gopher	do	Do.	Snowstorm	Whitewood	Do.
Grand Junction	Custer	Custer.	Sunday	Bear Butte	Do.
Great Eastern	Whitewood	Lawrence.	Union Hill	do	Do.
Hartford	Custer	Custer.	Washington	do	Do.
Hidden Treasure	Whitewood	Lawrence.	Yellow Jacket	do	Do.

GEORGIA.

Cheynegowah	New Hickory Flat	Cherokee.	Magruder		Hall.
Harris	Ninth	Hall.	Parks	Third	Cherokee.
Hayden	do	Do.	Sale		Lincoln.
Jennings	Republican	McDuffy.	Strickland	Third	Forsyth.
Kendrick		Cobb.	Wilkes	Latherville	Meriwether.

IDAHO.

Ada Elmore	Rocky Bar	Alturas.	California Boy	Sawtooth	Alturas.
Ada Elmore, first E. Ext	do	Do.	Cambria	do	Do.
Ada Elmore, second W. Ext	do	Do.	Cataract	Smiley's Basin	Do.
Adela	Shaw's Mountain	Boisé.	Centennial	Cañon Creek	Boisé.
Alabama	Sawtooth	Alturas.	Chance	Sawtooth	Alturas.
Albion	Smiley's Basin	Do.	Charity	Washington	Idaho.
Alps of Atlanta	Elk Creek	Do.	Charles Dickens	Yankee Fork	Lemhi.
Alta	Sawtooth	Do.	Clearbrook	Carson	Owyhee.
Alturas	Rocky Bar	Do.	Clipper	Wood River	Alturas.
American Star	Banner	Boisé.	Cloud	Flint	Owyhee.
Antelope	Yankee Fork	Lemhi.	Columbia	Sawtooth	Alturas.
Arabella	Hardscrabble	Alturas.	Comet	Bonaparte	Do.
Asteroid	Bonaparte	Do.	Comstock	Rocky Bar	Do.
Atanta	Sawtooth	Do.	Do	Sawtooth	Do.
Atlantic	Smiley's Basin	Do.	Do	Wagontown	Owyhee.
Avalanche	Red Warrior	Do.	Comstock S. E. Ext	Sawtooth	Alturas.
Banner	Banner	Boisé.	Confederate	Granite	Boisé.
Banner No. 2	do	Do.	Confederate Star	Rocky Bar	Alturas.
Banner W. Ext	do	Do.	Crane and Driggs	Carson	Owyhee.
Bannock	Carson	Owyhee.	Crown Point	Hardscrabble	Alturas.
Baxter	Sawtooth	Alturas.	Do	Banner	Boisé.
Do	Carson	Owyhee.	Do	South Mountain	Owyhee.
Bay State	South Mountain	Do.	Crown Point Bonanza	Hardscrabble	Alturas.
Beaver	Sawtooth	Alturas.	Crown Prince	Wagontown	Owyhee.
Beaver W. Ext	do	Do.	Cottonwood	South Mountain	Do.
Belle	Bonaparte	Do.	Custer	Sawtooth	Alturas.
Belle Cora	Wagontown	Owyhee.	Cynosure	Yankee Fork	Lemhi.
Belle Reade	Carson	Do.	Daisy	Rocky Bar	Alturas.
Belshazzar	Cañon Creek	Boisé.	Del Norte	Sawtooth	Do.
Big Croppings	Banner	Do.	Desdemona	Banner	Boisé.
Bismarck	Wagontown	Owyhee.	Disappointment	South Mountain	Owyhee.
Black Barb	Wood River	Alturas.	Dixie	Sawtooth	Alturas.
Blackbird	Mammoth	Boisé.	Dividend	Hardscrabble	Do.
Black Jack	Carson	Owyhee.	Donnybrook Fair	Red Warrior	Do.
Black Warrior	Banner	Boisé.	Duncan	Rocky Bar	Do.
Blue Ledge	Bonaparte	Alturas.	Ebenezer	Cañon Creek	Boisé.
Bonanza of Idaho	Rocky Bar	Do.	Ella	Carson	Owyhee.
Bonaparte Consolidated	Bonaparte	Do.	Elkhorn	Wood River	Alturas.
Bobtail	Sawtooth	Do.	Do	Elkhorn	Boisé.
Boise	do	Do.	Ellsworth	Carson	Owyhee.
Buffalo	Rocky Bar	Do.	Emma	Hardscrabble	Alturas.
Do	Middle Boisé	Do.	Do	Smiley's Basin	Do.
Buffalo and Atlantic	do	Do.	Emigrant	Sawtooth	Do.
Bullion	Rocky Bar	Do.	Do	Shaw's Mountain	Boisé.
Do	Wood River	Do.	Empire	Sawtooth	Alturas.
Bullwhacker	Shaw's Mountain	Boisé.	Do	Carson	Owyhee.
Do	Carson	Owyhee.	Empire, or Victoria	Banner	Boisé.
Burnt Pilot	Red Warrior	Alturas.	Estella	Wood River	Alturas.
Cabin Home No. 1	Sawtooth	Do.	Eunice	do	Do.
Cabin Home No. 2	do	Do.	Eureka	Sawtooth	Do.

DEEP MINES—Continued.

IDAHO—Continued.

Name of claim.	District.	County.
Eureka	Elkhorn	Boisé.
Fairview	Wood River	Alturas.
Ferguson	Smiley's Basin	Do.
Flagstaff	do	Do.
Florida Hill	Carson	Owyhee.
Galena	Wood River	Alturas.
Do	South Mountain	Owyhee.
Galveston	Banner	Boisé.
Gem of the Mountain	do	Do.
General Custer	Yankee Fork	Lemhi.
General Grant	Hardscrabble	Alturas.
Do	South Mountain	Owyhee.
Geneva	Sawtooth	Alturas.
Gladiator	Wood River	Do.
Glenbrook	Carson	Owyhee.
Golconda	South Mountain	Owyhee.
Gold Bar	Granite	Boisé.
Gold Hill	do	Do.
Golden Chariot	Queen's River	Alturas.
Do	Carson	Owyhee.
Golden Era	Elkhorn	Boisé.
Golden Rule	Wagontown	Owyhee.
Golden Star	Rocky Bar	Alturas.
Goldstone	Yankee Fork	Lemhi.
Gov. Bennett	Red Warrior	Alturas.
Gov. Morton	Queen's River	Do.
Gov. Morton S. Ext	do	Do.
Granite	Granite	Boisé.
Gray Eagle	Yankee Fork	Lemhi.
Great Western	Smiley's Basin	Alturas.
Green Mountain	Red Warrior	Do.
Hannibal	Sawtooth	Do.
Hastings Bros	South Mountain	Owyhee.
Hayes	Hardscrabble	Alturas.
Henrietta	Shaw's Mountain	Boisé.
Do	Wagontown	Owyhee.
High Reef	Sawtooth	Alturas.
Highland Chief	Wood River	Do.
Hidden Treasure	Sawtooth	Do.
Do	Shaw's Mountain	Boisé.
Do	Yankee Fork	Lemhi.
Home Resort	Carson	Owyhee.
Homestake	Wood River	Alturas.
Hudson	Smiley's Basin	Do.
Ibex	Elk Creek	Do.
Ida	Granite	Boisé.
Idaho	Sawtooth	Alturas.
Do	Yankee Fork	Lemhi.
Do	Wagontown	Owyhee.
Idaho or Keystone	Banner	Boisé.
Idahoan	Wood River	Alturas.
Idaho-Vishnu	Rocky Bar	Do.
Idlewild	Carson	Owyhee.
Illinois	Gambrinus	Boisé.
Illinois Central	Carson	Owyhee.
Illinois Central N. Ext	do	Do.
Independence	Rocky Bar	Alturas.
Do	Shaw's Mountain	Boisé.
Do	South Mountain	Owyhee.
Iowa	Smiley's Basin	Alturas.
Do	Granite	Boisé.
Itasca	Rocky Bar	Alturas.
Jay Gould	Wood River	Do.
J. B. Dodge	Wagontown	Owyhee.
J. B. Warren	do	Do.
Jessie	South Mountain	Alturas.
Jessie Benton	Middle Boisé	Do.
Joe Daly	Queen's River	Do.
Joe Daly first E. Ext	do	Do.
Joe Daly second W. Ext	do	Do.
John Bell	Granite	Boisé.
John Schaeffer	Red Warrior	Alturas.
Josephine	Carson	Owyhee.
Justice	Granite	Boisé.
Keystone	Wood River	Alturas.
King Bee	Shaw's Mountain	Boisé.
Ladd & Reed	Carson	Owyhee.
Lady Franklin	Sawtooth	Alturas.
Lake	do	Do.
Do	Yankee Fork	Lemhi.
Last Chance	Hardscrabble	Alturas.
Do	Smiley's Basin	Do.
Do	Yankee Fork	Lemhi.
Do	Wagontown	Owyhee.
Lawyer	Granite	Boisé.
Laxey	South Mountain	Owyhee.
Lemhi	Smiley's Basin	Alturas.
Lion	do	Do.
Little Joe Daly	Queen's River	Do.
Little Rhody	South Mountain	Owyhee.
Live Yankee	Queen's River	Alturas.
Lone Star	Granite	Boisé.
Lone Tree	Carson	Owyhee.
Lookout	Wood River	Alturas.
Lucky Boy	Sawtooth	Do.
Lyman Ward	Bonaparte	Do.
Maggie	Wagontown	Owyhee.
Magnetic Iron	South Mountain	Do.
Mahogany or Corduroy	Carson	Do.
Mammoth	North Fork	Alturas.
Do	Queen's River	Do.
Do	Rocky Bar	Do.
Do	Sawtooth	Do.
Do	Mammoth	Boisé.
Mammoth first W. Ext	North Fork	Alturas.
Mammoth second W. Ext	do	Do.

Name of claim.	District.	County.
Mariposa	Hardscrabble	Alturas.
Martin	Smiley's Basin	Do.
Mary Blaine	Carson	Owyhee.
Mayflower	Wood River	Alturas.
Do	Granite	Boisé.
Midas	Bonaparte	Alturas.
Minnie Moore	Wood River	Do.
Monarch	Middle Boisé	Do.
Do	Wagontown	Owyhee.
Mono	Sawtooth	Alturas.
Do	South Mountain	Owyhee.
Montana	Smiley's Basin	Alturas.
Do	Yankee Fork	Lemhi.
Morning Star	Shaw's Mountain	Boisé.
Do	Carson	Owyhee.
Moses	Shaw's Mountain	Boisé.
Mountain Buck	Rocky Bar	Alturas.
Mountain Chief	Sawtooth	Do.
Do	Cañon Creek	Boisé.
Mudhole	Sawtooth	Alturas.
Napias	do	Do.
Nellie	Smiley's Basin	Do.
Nellie W. Ext	do	Do.
Ne Plus Ultra	Bonaparte	Do.
New Ophir	Hardscrabble	Do.
New Ophir first E. Ext	do	Do.
New Ophir second E. Ext	do	Do.
New York	Red Warrior	Do.
New York and Ohio	Bonaparte	Do.
North Empire	Carson	Owyhee.
North Star	Wood River	Alturas.
Do	Shaw's Mountain	Boisé.
North Star E. Ext	do	Do.
Numkeg	South Mountain	Owyhee.
Oakland	Smiley's Basin	Alturas.
Ohio	Wagontown	Owyhee.
O. K	Wood River	Alturas.
Old Chunk	Middle Boisé	Do.
Ontario	Wood River	Do.
Ophir	do	Do.
Oregon	Smiley's Basin	Do.
Orient	Wood River	Do.
Original	South Mountain	Owyhee.
Oro Fino	Queen's River	Alturas.
Do	Carson	Owyhee.
Oswego	Wood River	Alturas.
Owyhee	Carson	Owyhee.
Owyhee Treasury	Carson	Owyhee.
Panamint	Banner	Boisé.
Parole	Shaw's Mountain	Do.
Pauper	Carson	Owyhee.
Paymaster	Shaw's Mountain	Boisé.
Pennsylvania	Banner	Do.
Perseverance	Flint	Owyhee.
Phil. Sheridan	Sawtooth	Alturas.
Pickens & Edwards	Flint	Owyhee.
Pilgrim	Sawtooth	Alturas.
Pilgrim's Mother	Smiley's Basin	Do.
Pinafore	Shaw's Mountain	Boisé.
Pinto	Sawtooth	Alturas.
Pioneer	Granite	Boisé.
Do	Yankee Fork	Lemhi.
Plymouth	Sawtooth	Alturas.
Polar Star	South Mountain	Owyhee.
Pompeii	Sawtooth	Alturas.
Poorman	Hardscrabble	Do.
Do	Carson	Owyhee.
Poorman N. Ext	do	Do.
Potosi	do	Do.
Pride of the West	Sawtooth	Alturas.
Do	Shaw's Mountain	Boisé.
Rainbow	Wagontown	Owyhee.
Ramahorn	Bay Horse	Lemhi.
Rattling Jack	Carson	Owyhee.
Red Bird	Wood River	Alturas.
Red Elephant	do	Do.
Red Fox	South Mountain	Owyhee.
Red Jacket	Carson	Do.
Do	South Mountain	Do.
Rescue	Washington	Idaho.
Revenue	Carson	Owyhee.
Richmond	Sawtooth	Alturas.
Rising Sun	do	Do.
Do	Shaw's Mountain	Boisé.
Rising Star	Flint	Owyhee.
Rising Star N. Ext	do	Do.
Robie	South Mountain	Do.
Rose	do	Do.
Rough and Ready	Wood River	Alturas.
Ruby	Sawtooth	Do.
Ruth	Carson	Owyhee.
Sands or Silver City	do	Do.
Savage	Queen's River	Alturas.
Do	Sawtooth	Do.
Sawtooth	Smiley's Basin	Do.
Scorpion	Wood River	Do.
Scotia	Sawtooth	Do.
Senator	Wood River	Do.
Sherman	Hardscrabble	Do.
Shoshone	Sawtooth	Do.
Silver Beam	Bonaparte	Do.
Silver Chief	Banner	Boisé.
Silver Cord	Carson	Owyhee.
Silver Glance	Queen's River	Alturas.
Silver King	Smiley's Basin	Do.
Do	Shaw's Mountain	Boisé.

DEEP MINES—Continued.

IDAHO—Continued.

Name of claim.	District.	County.	Name of claim.	District.	County.
Silver Peak	Banner	Boisé.	Washoe	Banner	Boisé.
South Empire	Carson	Owyhee.	Washington	Sawtooth	Alturas.
South Chariot	do	Do.	Do	Queen's River	Do.
St. Clair	Wagontown	Do.	Washington S. Ext	do	Do.
St. John	do	Do.	Webfoot	Smiley's Basin	Do.
Star of the West	Banner	Boisé.	Do	Wagontown	Owyhee.
Star	Wood River	Alturas.	West Confederate Star	Rocky Bar	Alturas.
Stoddard	Wagontown	Owyhee.	Whale	Yankee Fork	Lemhi.
Stormy Hill	Carson	Do.	Whisky	Carson	Owyhee.
Steward	Bonaparte	Alturas.	Whisky Gulch	do	Do.
Sub Rosa	Gambrinus	Boisé.	White Bird	Wood River	Alturas.
Summit	Yankee Fork	Lemhi.	Wide West	Red Warrior	Do.
Summit No. 1	Sawtooth	Alturas.	Do	Carson	Owyhee.
Summit No. 2	do	Do.	Wildcat	Red Warrior	Alturas.
Sunbeam	do	Do.	Wilson	Wagontown	Owyhee.
Sunburst	do	Do.	Wire Silver	Sawtooth	Alturas.
Surplus North Empire	Carson	Owyhee.	Witch of Owyhee	Carson	Owyhee.
Surplus Oro Fino	do	Do.	Wizard King	Rocky Bar	Alturas.
Tabosa	Middle Boisé	Alturas.	Wolverine	Banner	Boisé.
Tenino	Red Warrior	Do.	Wolverine N. E. Ext	do	Do.
Tip Top	Sawtooth	Do.	Yankee	Yankee Fork	Lemhi.
Tonto	Yankee Fork	Lemhi.	Yankee Fork	do	Do.
Triumph	Bonaparte	Alturas.	Yellow Jacket	Granite	Boisé.
Unknown	Yankee Fork	Lemhi.	Yellow Jacket N. E. Ext	do	Do.
Victor	Red Warrior	Alturas.	Yreka	South Mountain	Owyhee.
Vienna	Smiley's Basin	Do.	Zulu	Wagontown	Do.
War Eagle	Carson	Owyhee.			

MAINE.

Acton Consolidated	Acton	York.	Goldsboro	Goldsboro	Hancock.
Ashley	Sullivan	Hancock.	Harrington	Carmel	Penobscot.
Cherryfield	Fifth	Washington.	Milton	Sullivan	Hancock.
Consolidated Hampden		Penobscot.	Sullivan	West Sullivan	Do.
Deer Isle	Goldsboro	Hancock.	Waukeg	Sullivan	Do.
Golden Circle	Sullivan	Do.			

MONTANA.

Albion	Silver Creek	Deer Lodge.	Keating	Cedar Plains	Jefferson.
Algonquin	Flint Creek	Do.	Keokuk	Trapper	Beaver Head.
Alice	Summit Valley	Do.	Late Acquisition	Summit Valley	Deer Lodge.
Alta		Jefferson.	Lexington	do	Do.
A. M. Holte	Elkhorn	Do.	Little Giant	Montana	Jefferson.
Anaconda	Summit Valley	Deer Lodge.	Mantle	Cataract	Do.
Anglo-Saxon	do	Do.	McClellan Gulch	McClellan Gulch	Deer Lodge.
Anselmo	do	Do.	Morning Star	Summit Valley	Do.
Aurora Borealis	Silver Star	Madison.	Mount Pleasant	Stemple	Lewis and Clarke.
Bell	Summit Valley	Deer Lodge.	Mountain Boy	Independence	Deer Lodge.
Belmont	Silver Creek	Lewis and Clarke.	National	Summit Valley	Do.
Bluebird	Stemple	Do.	Nettie	do	Do.
Blue Grass	Bannock	Beaver Head.	North Star	do	Do.
Boaz	Lower Hot Spring	Madison.	Penobscot	Silver Creek	Do.
Bonanza Chief		Jefferson.	Red Bluff	Hot Springs	Madison.
Boulder	Cataract	Do.	Red Cliff	do	Do.
Bradway	Silver Star	Madison.	Salmon	Flint Creek	Deer Lodge.
Clear Grit	Summit Valley	Deer Lodge.	Sandford	Stemple	Lewis and Clarke.
Colusa	do	Do.	Scratch Owl	Flint Creek	Deer Lodge.
Coro	do	Do.	Self-rising	Independence	Do.
Cordwainer	Red Bluff	Madison.	Shakespeare	Summit Valley	Do.
Dakota	Bannock	Beaver Head.	Shonbar	do	Do.
Dakota No. 5	do	Do.	Silverbow	do	Do.
Deer Lodge		Deer Lodge.	Snowbridge	Silver Creek	Do.
Drumlommond	Ottawa	Lewis and Clarke.	Speckled Trout	Flint Creek	Do.
Excelsior	Bannock	Beaver Head.	Springfield	Bannock	Beaver Head.
Hikborn	Bald Mountain	Do.	Do	Summit Valley	Deer Lodge.
French	Bannock	Do.	Star West	do	Do.
Gagnon	Summit Valley	Deer Lodge.	Stevens	do	Do.
Golden Leaf	Bannock	Beaver Head.	Union No. 2	Owyhee	Lewis and Clarke.
Grasshopper	Silver Star	Madison.	Utah	Summit Valley	Deer Lodge.
Grub Stake	Silver Shower	Do	Volunteer	do	Do.
Hecla Consolidated	Trapper	Beaver Head.	Wabash	do	Do.
Hickey	Stemple	Lewis and Clarke.	Washington	Bannock	Beaver Head.
High Ore	Summit Valley	Deer Lodge.	Whippoorwill	Stemple	Lewis and Clarke.
Hope	Flint Creek	Do.	White Pine	Mineral Hill	Madison.

NEVADA.

Adams Hill Consolidated	Tuscarora	Elko.	American	The Comstock	Storey.
Adventure	Mount Rose	Humboldt.	Do	do	Do.
Agassiz	The Comstock	Storey.	American Eagle	do	Do.
Alabama	do	Do.	American Flag	Lincoln	Pioche.
Alameda	Union	Nye.	American Flat	The Comstock	Storey.
Albion	Eureka	Eureka.	Andes	do	Do.
Alexander	The Comstock	Storey.	Andrews	do	Do.
Alexandria	Eureka	Do.	Antelope	Esmeralda	Esmeralda.
Alhambra	The Comstock	Do.	Arctic	The Comstock	Storey.
Alice	Buckskin	Humboldt.	Argenta	Tuscarora	Elko.
Allen or Peruvian	The Comstock	Storey.	Argonaut	The Comstock	Storey.
Alpha	do	Do.	Arizona	do	Do.
Alpine	do	Do.	Do	Montezuma	Esmeralda.
Alta	do	Do.	Arthur	Mount Rose	Humboldt.
Alta (patent)	do	Do.	Astor	Silver Peak	Esmeralda.
Amazon	do	Do.	Atlantic	The Comstock	Storey.
Do	Good Hope	Elko.	Aurora	Good Hope	Elko.
America	The Comstock	Storey.	Do	Esmeralda	Esmeralda.

DEEP MINES—Continued.

NEVADA—Continued.

Name of claim.	District.	County.
Bailey	The Comstock	Storey.
Balnartel	Columbus	Esmeralda.
Baltic	The Comstock	Storey.
Baltimore American	do	Do.
Baltimore Consolidated	do	Do.
Basin	Tuscarora	Elko.
Bayfield	I. X. L	Churchill.
Belchapin	The Comstock	Storey.
Belcher	do	Do.
Belcher Extension	do	Do.
Belding	Columbus	Esmeralda.
Belle Isle	Tuscarora	Elko.
Belmont	Philadelphia	Nye.
Benjamin	The Comstock	Storey.
Benton	do	Do.
Best & Belcher	do	Do.
Big Indian	Mount Grant	Esmeralda.
Big Nick	Mount Rose	Humboldt.
Big Prize	do	Do.
Bismarck	Columbus	Esmeralda.
Black Horse	Black Mountain	Do.
Do	Cambridge	Do.
Black Prince	I. X. L	Churchill.
Black Warrior	Silver Peak	Esmeralda.
Blaisdell	Cambridge	Do.
Bluebell	Mount Rose	Humboldt.
Blue Jacket	Blue Jacket	Elko.
Do	The Comstock	Storey.
Bochler	do	Do.
Bonanza	do	Do.
Bournelly	Gillis Mountain	Nye.
Boyle	The Comstock	Storey.
Brilliant	do	Do.
Brooklyn	Union	Nye.
Brown	The Comstock	Storey.
Brown's Hope	Lida Valley	Esmeralda.
Buckeye	Good Hope	Elko.
Do	The Comstock	Storey.
Bullion	do	Do.
Do	Montezuma	Esmeralda.
Bullion of Paradise	Mount Rose	Humboldt.
Burning Moscow	Columbus	Esmeralda.
Caldwell	The Comstock	Storey.
Caledonia	do	Do.
California	do	Do.
Do	do	Do.
Do	Eureka	Eureka.
California Bank	The Comstock	Storey.
Capital	do	Do.
Capital No. 2	do	Do.
Caroline	do	Do.
Do	do	Do.
Carson	do	Do.
Catskill	Tuscarora	Elko.
Cavour	The Comstock	Storey.
Centennial	Esmeralda	Esmeralda.
Do	Lida Valley	Do.
Center Lode	Columbus	Do.
Cherokee	The Comstock	Storey.
Chief of the Hill	Columbus	Esmeralda.
Chieftain	Silver Peak	Do.
Chihuahua	Esmeralda	Do.
Chloride	Columbus	Do.
Choliar	The Comstock	Storey.
Chonta	do	Do.
Do	do	Do.
Cinderella	Lida Valley	Esmeralda.
City of Melbourne	The Comstock	Storey.
Clemens	do	Do.
Cliff House	do	Do.
Clyde	do	Do.
Coal Burner	Oneota	Esmeralda.
Cole	The Comstock	Storey.
Colorado	do	Do.
Colossus	do	Lo.
Columbia	do	Do.
Do	Columbus	Esmeralda.
Columbia Consolidated	Columbia	Elko.
Columbus	Rebel Creek	Humboldt.
Comet	The Comstock	Storey.
Comet Extension	do	Do.
Compromise	do	Do.
Concordia	do	Do.
Confidence	do	Do.
Cortes	Esmeralda	Esmeralda.
Consolidated Virginia	The Comstock	Storey.
Cook & Gray	do	Do.
Cosmopolitan	do	Do.
Do	do	Do.
Coso	do	Do.
Coupon	do	Do.
Coupon No. 2	do	Do.
Coyo	do	Do.
Crevice	do	Do.
Crocket	Esmeralda	Esmeralda.
Cræsus	Rebel Creek	Humboldt.
Cromer	The Comstock	Storey.
Crowning Glory	Silver Peak	Esmeralda.
Crown Point	The Comstock	Storey.
Crown Point Extension	do	Do.
Crown Point Ravine	do	Do.
Crystal Ridge	do	Do.
Culver	do	Do.
Culver addition	do	Do.
Curtis	do	Do.

Name of claim.	District.	County.
Curtis	Reese River	Lander.
Daney	The Comstock	Storey.
Daniel Webster	do	Do.
Dardanelles	do	Do.
Day	Jack Rabbit	Lincoln.
Dayton	The Comstock	Storey.
Dayton No. 2	do	Do.
Dean	do	Do.
Death Valley	Lida Valley	Esmeralda.
De Forest	The Comstock	Storey.
De Frees	Tuscarora	Elko.
Delaware	The Comstock	Storey.
Del Rey	do	Do.
Dexter	do	Do.
Diamond	do	Do.
Dinero	Columbus	Esmeralda.
Dios Señor	The Comstock	Storey.
Dolores	Pine Grove	Esmeralda.
Doran	Columbus	Do.
Drexel	The Comstock	Storey.
Drinkwater	Silver Peak	Esmeralda.
Dunderberg	Eureka	Eureka.
E. Chapin	The Comstock	Storey.
E. Comstock	do	Do.
E. Europa	do	Do.
E. Overman	do	Do.
E. Savage	do	Do.
E. Star	do	Do.
E. Yellow Jacket	do	Do.
Eagle	Eureka	Eureka.
Eastern Belle	Columbus	Esmeralda.
Eastern Slope	Esmeralda	Do.
Do	Buckskin	Humboldt.
Eastern Star	I. X. L	Churchill.
East Mount Diablo	Columbus	Esmeralda.
Eberhardt and Aurora	White Pine	White Pine.
Edinburgh	The Comstock	Storey.
Eldorado No. 3	Eureka	Eureka.
Elevator	The Comstock	Storey.
Ella	Good Hope	Elko.
Elliot	The Comstock	Storey.
Ellsworth	Mammoth	Nye.
Emma	Buckskin	Humboldt.
Do	Rebel Creek	Do.
Emigrant	The Comstock	Storey.
Empire	Esmeralda	Esmeralda.
Enderwood	The Comstock	Storey.
Endowment	Black Mountain	Esmeralda.
English Company	The Comstock	Storey.
Enterprise	do	Do.
Do	Columbus	Esmeralda.
Equator	do	Do.
Esmeralda	Esmeralda	Do.
Esperance	The Comstock	Storey.
Esperanza	do	Do.
Essex	do	Do.
Esta Buena	Mammoth	Nye.
Estelle	The Comstock	Storey.
Ethan Allen	Rebel Creek	Humboldt.
Eureka	Eureka	Eureka.
Europa	The Comstock	Storey.
Excelsior	Silver Mountain	Esmeralda.
Excelsior Consolidated	Esmeralda	Do.
Exchange	Cherry Creek	White Pine.
Exchequer	The Comstock	Storey.
Fairfax	do	Do.
Falcon	Rock Creek	Elko.
Flora Temple	The Comstock	Storey.
Florida	do	Do.
Fourth of July	Eureka	Eureka.
Francisco Marsano	The Comstock	Storey.
Frankel	do	Do.
Franklin-German	do	Do.
French	do	Do.
Front Lode Consolidated	do	Do.
Fry	do	Do.
Do	do	Do.
Garibaldi	Esmeralda	Esmeralda.
Garrison	Cortes	Eureka.
Geddes & Bertrand	Secret Cañon	Do.
Genesee	The Comstock	Storey.
General Jackson	Columbus	Esmeralda.
General Thomas	do	Do.
General Washington	do	Do.
Georgia	The Comstock	Storey.
German	do	Do.
Gila	do	Do.
Do	Reveille	Nye.
Gladding	Volcano	Esmeralda.
Glasgow	The Comstock	Storey.
Glen	do	Do.
Globe	do	Do.
Glory	Silver Peak	Esmeralda.
Do	Mount Rose	Humboldt.
Golden Age	Esmeralda	Esmeralda.
Golden Arrow	The Comstock	Storey.
Gold Hill	do	Do.
Gold Hill Tunnel	do	Do.
Gold Lead	do	Do.
Gold Leaf	do	Do.
Gold Note	Rock Creek	Elko.
Goodman	The Comstock	Storey.
Gould & Curry	do	Do.
Grand Prize	Tuscarora	Elko.
Grant	The Comstock	Storey.

DEEP MINES—Continued.

NEVADA—Continued.

Name of claim.	District.	County.
Great American Rooster	Union	Nye.
Great Eastern	The Comstock	Storey.
Great Western	do	Do.
Do	Cambridge	Esmeralda.
Green	The Comstock	Storey.
Green Mountain	Silver Star	Esmeralda.
Grosh	The Comstock	Storey.
Grosh Consolidated	do	Do.
Gulch	Mount Rose	Humboldt.
Hale & Norcross	The Comstock	Storey.
Hale & Norcross, S. E. Ext	do	Do.
Hamburg	Eureka	Eureka.
Hardy	The Comstock	Storey.
Harlem	do	Do.
Hartford	do	Do.
Hawkeye	do	Do.
Hawley Consolidated	do	Do.
Hayward	do	Do.
Hector	do	Do.
Henry Clay	do	Do.
Hercules	do	Do.
Highbridge	Philadelphia	Nye.
Hillside	Bristol	Lincoln.
Do	The Comstock	Storey.
Holman	do	Do.
Holmes	Columbus	Esmeralda.
Homestake	Silver Peak	Do.
Hoosac	Eureka	Eureka.
Humboldt	Esmeralda	Esmeralda.
Idaho	Eureka	Eureka.
Illinois	Lodi	Nye.
Imperial	The Comstock	Storey.
Independence	Tuscarora	Elko.
Independent	The Comstock	Storey.
Indianapolis	Union	Nye.
Indian Queen	Oneota	Esmeralda.
Indian Queen No. 2	do	Do.
Indian Queen No. 3	do	Do.
Indian Queen No. 4	do	Do.
Industry	The Comstock	Storey.
Insurance	do	Do.
Inter-ocean	Alum Creek	Esmeralda.
Iowa	The Comstock	Storey.
Iowa Consolidated	Rebel Creek	Humboldt.
Irving	The Comstock	Storey.
I. X. L.	I. X. L.	Churchill.
Jackson	Eureka	Eureka.
Do	The Comstock	Storey.
Jacob Little	do	Do.
James	do	Do.
Joe Bates	do	Do.
John Amer	do	Do.
Jolly	Columbus	Esmeralda.
Julia	The Comstock	Storey.
Julia E. Ext	do	Do.
Julia No. 2	do	Do.
Jumper	Silver Star	Esmeralda.
Juniata	Esmeralda	Do.
Jura	The Comstock	Storey.
Justice	do	Do.
Do	Oneota	Esmeralda.
Kale Seed	do	Do.
Kate	The Comstock	Storey.
Kennebec	do	Do.
Kentuck	Central	Esmeralda.
Keystone	The Comstock	Storey.
Do	do	Do.
Kit Carson	Eureka	Eureka.
K. K. Consolidated	do	Do.
Knickerbocker	The Comstock	Storey.
Kossuth	do	Do.
Kossuth Ext	do	Do.
Lady Washington	do	Do.
La Fayette	do	Do.
Lang Syne	Sierra	Humboldt.
Lansan	The Comstock	Storey.
La Plata	do	Do.
Lassen	do	Do.
Last Chance	Esmeralda	Esmeralda.
Do	Silver Peak	Do.
Do	Mammoth	Nye.
Lawson	The Comstock	Storey.
Leo	do	Do.
Leopard	Cornucopia	Elko.
Leviathan	The Comstock	Storey.
Lexington	do	Do.
Do	Esmeralda	Esmeralda.
Liberty	San Antonio	Nye.
Lida Belle	Lida Valley	Esmeralda.
Lida Hill	do	Do.
Lime Point	Silver Star	Do.
Lincoln	The Comstock	Storey.
Lisbon	Mammoth	Nye.
Little Giant	The Comstock	Storey.
Little Potosi	Columbus	Esmeralda.
Little York	The Comstock	Storey.
Lloyd	Union	Nye.
Lodi	Lodi	Do.
[illegible]nut	The Comstock	Storey.
[illegible] of Lorne	do	Do.
[illegible]siana	Montezuma	Esmeralda.
Lowery	The Comstock	Storey.
Low Range	do	Do.
Lucerne	do	Do.
Lucky Dog	Buena Vista	Humboldt.

Name of claim.	District.	County.
Lucky Hill	Columbus	Esmeralda.
Mackey	The Comstock	Storey.
Macon City	Eureka	Eureka.
Magnet	Columbus	Esmeralda.
Mammoth	Mount Rose	Humboldt.
Manhattan	Rock Creek	Elko.
Do	Reese River	Lander.
Manhattan Consolidated	The Comstock	Storey.
Margarita	do	Do.
Margarita No. 2	do	Do.
Marietta	Buckskin	Humboldt.
Marsano	The Comstock	Storey.
Marvel	do	Do.
Mary	do	Do.
Mary Ann	do	Do.
Maryland	do	Do.
Mary Wilder	Congo	Humboldt.
Mayflower	Mount Rose	Do.
McErlain	The Comstock	Storey.
McGlunis & Bacon	do	Do.
McKibben	do	Do.
McMahon & Irvine	Union	Nye.
Meadow Valley	Ely	Lincoln.
Mennon	The Comstock	Storey.
Memphis	do	Do.
Mendha	Bristol	Lincoln.
Metallic	Columbus	Esmeralda.
Metela	The Comstock	Storey.
Metropolitan	do	Do.
Mexican	do	Do.
Miami	do	Do.
Midas	do	Do.
Mint	do	Do.
Mississippi	do	Do.
Missouri	do	Do.
Mitchell	do	Do.
Modoc Chief	do	Do.
Monitor	Montezuma	Esmeralda.
Monitor Belmont	Philadelphia	Nye.
Monte Christo	The Comstock	Storey.
Monte Christo No. 2	do	Do.
Monumental	do	Do.
Mooney & Whiteman	do	Do.
Moore & Morgan	do	Do.
Morning Star No. 2	do	Do.
Mountain Buck	Buckskin	Humboldt.
Mountain King	Bradshaw	Do.
Mountain View	The Comstock	Storey.
Mount Diablo	Columbus	Esmeralda.
Mount Potosi	do	Do.
Mount Vernon	Mammoth	Nye.
Morey	Morey	Do.
Murphy	Twin River	Do.
N. Chipman	The Comstock	Storey.
N. Comstock	do	Do.
N. Consolidated Virginia	do	Do.
N. Dayton	do	Do.
N. Knickerbocker	do	Do.
N. Lexington	do	Do.
N. Mexican	do	Do.
N. Milton	do	Do.
N. Occidental	do	Do.
N. Ophir	do	Do.
N. Prospect	do	Do.
N. Star	do	Do.
Do	do	Do.
Nagle	do	Do.
Navajo	Tuscarora	Elko.
Nevada	Montezuma	Esmeralda.
Do	The Comstock	Storey.
Nevada No. 2	do	Do.
New Boston	Silver Star	Nye.
New Empire State	The Comstock	Storey.
New England	Columbus	Esmeralda.
New Oregon	The Comstock	Storey.
New York	do	Do.
Do	Silver Peak	Esmeralda.
Niagara	The Comstock	Storey.
Nigger Ravine	do	Do.
North	do	Do.
North Belle Isle	Tuscarora	Elko.
Northern Belle	Columbus	Esmeralda.
Northern Light	The Comstock	Storey.
Occidental	do	Do.
Do	Rock Creek	Elko.
Ohio	Good Hope	Do.
Do	Rebel Creek	Humboldt.
Do	The Comstock	Storey.
Ontario	do	Do.
Do	Blue Jacket	Elko.
Ophir	The Comstock	Storey.
Original Gold Hill	do	Do.
Orleans	do	Do.
Ore	do	Do.
Overman	do	Do.
Overman No. 2	do	Do.
Overton	do	Do.
Page & Kelly	Good Hope	Elko.
Palmetto	The Comstock	Storey.
Panther	Cornucopia	Elko.
Paradise Valley	Mount Rose	Humboldt.
Patten	The Comstock	Storey.
Paymaster	Rebel Creek	Humboldt.
Do	Ward	White Pine.
Pearson	The Comstock	Storey.

DEEP MINES—Continued.

NEVADA—Continued.

Name of claim.	District.	County.
Pedro	Columbus	Esmeralda.
Peru	do	Do.
Peytona	The Comstock	Storey.
Phœnix	Eureka	Eureka.
Phœnix-Western	The Comstock	Storey.
Picton	do	Do.
Pioneer	do	Do.
Pinte	do	Do.
Do	Mammoth	Nye.
Plato	The Comstock	Storey.
Pleiades	Ward	White Pine.
Plutus	The Comstock	Storey.
Pocotillo	Silver Peak	Esmeralda.
Poor	Esmeralda	Do.
Porphyry	The Comstock	Storey.
Potosi	do	Do.
Pride of the Mountain	Winnemucca	Humboldt.
Pride of Washoe	The Comstock	Storey.
Prospect	do	Do.
Prospectus	Esmeralda	Esmeralda.
R. & W. Cross	The Comstock	Storey.
Rattler	Good Hope	Elko.
Do	Mount Rose	Humboldt.
Raymond & Ely	Ely	Lincoln.
Real del Monte	Esmeralda	Esmeralda.
Red Deer	Mount Rose	Humboldt.
Red Hill	do	Do.
Reno	The Comstock	Storey.
Richmond	Columbus	Esmeralda.
Do	Eureka	Eureka.
Rock Island	The Comstock	Storey.
Rocky Bar	do	Do.
Roddy	Silver Star	Humboldt.
Roman Capital	The Comstock	Storey.
Royal	Bradshaw	Humboldt.
R. R. Consolidated	The Comstock	Storey.
Ruby	Rock Creek	Elko.
S. Belcher	The Comstock	Storey.
S. California	do	Do.
S. Chipman	do	Do.
S. Consolidated Virginia	do	Do.
S. Crosh	do	Do.
S. Star	do	Do.
S. St. Louis	do	Do.
Sacramento	do	Do.
Sadie	do	Do.
Sallie Hart	do	Do.
San Francisco	do	Do.
San Francisco Belle	Black Mountain	Esmeralda.
Santiago	The Comstock	Storey.
Sapphire	Lida Valley	Esmeralda.
Saratoga	Columbia	Do.
Do	Montezuma	Do.
Savage	Columbus	Do.
Do	The Comstock	Storey.
Sawana	Lida Valley	Esmeralda.
Schiller	Columbus	Do.
Scorpion	The Comstock	Storey.
Seg. Belcher	do	Do.
Seminole	Esmeralda	Esmeralda.
Senator	The Comstock	Storey.
Sewell & Shoel	do	Do.
Shamo	do	Do.
Shanley	do	Do.
Shawmut Consolidated	Montezuma	Esmeralda.
Sheridan	The Comstock	Storey.
Sherwood	do	Do.
Sierra	do	Do.
Sierra Nevada	do	Do.
Silverado	do	Do.
Silver Bill	Bradshaw	Humboldt.
Silver Brick	Good Hope	Elko.
Silver Central	The Comstock	Storey.
Silver Champion	Central	Esmeralda.
Silver Conner		Storey.
Silver Eagle	Silver Peak	Esmeralda.
Silver Hill	The Comstock	Storey.
Silver Leaf	do	Do.
Silver Lick	Eureka	Eureka.
Silver Prize	Tuscarora	Elko.
Silver Star	do	Do.
Do	The Comstock	Storey.
Silver Wave	Rebel Creek	Humboldt.
Silver Wedge	Mount Rose	Do.
Sinder	Good Hope	Elko.
Solid Silver	Congo	Humboldt.
Do	The Comstock	Storey.
South Buckeye	do	Do.
South Comstock	do	Do.
South End	do	Do.
South Jacket	do	Do.
South Lucerne	do	Do.
South Overman	do	Do.
Southern Nevada	Columbus	Esmeralda.
Spar	I. X. L.	Churchill.
Stafford	White Pine	White Pine.
Star	Cherry Creek	White Pine.
Star of Nevada	Columbus	Esmeralda.
Starr & Grove	Lewis	Lander.
State Line	Gold Mountain	Esmeralda.
Sterling	Buckskin	Humboldt.
Stevens	The Comstock	Storey.
St. John's	do	Do.
St. Lawrence	do	Do.
St. Louis	do	Do.
Storey	do	Do.
Storm King	Union	Nye.
Street and Blanche	Mount Rose	Humboldt.
Stump & Adams	Columbus	Esmeralda.
Sucoor	The Comstock	Storey.
Sullivan	do	Do.
Summit	Cambridge	Esmeralda.
Sunrise	Silver Peak	Do.
Do	Volcano	Do.
Do	The Comstock	Storey.
Surprise	do	Do.
Sutro	do	Do.
Swan	do	Do.
T. and C. Brooks	do	Do.
Table Mountain	do	Do.
Tam O'Shanter	do	Do.
Tarto	do	Do.
Techatticup and Savage	Eldorado	Lincoln.
Tehama	The Comstock	Storey.
Thanksgiving	Esmeralda	Esmeralda.
Thornberg	The Comstock	Storey.
Thornton	do	Do.
Tiger	Good Hope	Elko.
Tikup	Cherry Creek	White Pine.
Tilden	Columbus	Esmeralda.
Tipton	do	Do.
Troy Consolidated	The Comstock	Storey.
Tucker	do	Do.
Tuscarora	Blue Jacket	Elko.
Do	Tuscarora	Do.
Tucson	Mount Rose	Humboldt.
Twin	The Comstock	Storey.
Twin Peaks	do	Do.
Tybo	Tybo	Nye.
Tyro	The Comstock	Storey.
Union Consolidated	do	Do.
Uranus	Mount Rose	Humboldt.
Utah	Esmeralda	Esmeralda.
Do	The Comstock	Storey.
Utah first N. E. Ext	do	Do.
Utah second N. E. Ext	do	Do.
Valiant	Silver Peak	Esmeralda.
Vanderbilt	Columbus	Do.
do	Silver Peak	Do.
Venus	The Comstock	Storey.
Vermont	do	Do.
Victor	Columbus	Esmeralda.
do	Union	Nye.
Victoria-Garber	The Comstock	Storey.
Virginia Standard	do	Do.
Vivian	do	Do.
Volcano	do	Do.
Vulcan	do	Do.
Vulture	Black Mountain	Esmeralda.
W. Belcher	The Comstock	Storey.
W. Crown Point	do	Do.
W. Justice	do	Do.
W. Star	do	Do.
Walah	Columbus	Esmeralda.
Ward	The Comstock	Storey.
Wasatch	do	Do.
Washoe Consolidated	do	Do.
Wasson	Silver Star	Esmeralda.
Waters	The Comstock	Storey.
Webber	do	Do.
Wells Fargo	do	Do.
Western	do	Do.
Western Soldier	Silver Peak	Esmeralda.
Whale	Rock Creek	Elko.
Wheeler	Wilson	Esmeralda.
White Deer	Mount Rose	Humboldt.
White Pine	Lodi	Nye.
Wide West	Esmeralda	Esmeralda.
Wild Goose	Mount Rose	Humboldt.
Williams	Cambridge	Esmeralda.
Williamsburg	Eureka	Eureka.
Willis	Columbus	Esmeralda.
Wilson	Wilson	Do.
Windsor	Columbus	Do.
Winnemuck	Esmeralda	Do.
Woodville	The Comstock	Storey.
Yankee	do	Do.
Yellow Chief	Columbus	Esmeralda.
Yellow Jacket	The Comstock	Storey.
You and I	Good Hope	Elko.
Young America	Esmeralda	Esmeralda.

NEW HAMPSHIRE.

Bedell	Ammonoosuc	Grafton.	Shelburne	Shelburne	Coos.
Little May	do	Do.			

DEEP MINES—Continued.

NEW MEXICO.

Name of claim.	District.	County.	Name of claim.	District.	County.
Commercial	Miembres	Grant.	Naiad Queen	Miembres	Grant.
Cosette	Lone Mountain	Do.	Ohio	Pinos Altos	Do.
Lanston	Pinos Altos	Do.	Pacific No. 2	do	Do.
Marshall Benzana	Las Cerrillos	Santa Fé.	Providence	Chloride Flat	Do.
Massachusetts	Pinos Altos	Grant.	San Pedro	Silver Butte	Santa Fé.
McGregor	Miembres	Do.	Seventy-six, or Bremen	Chloride Flat	Grant.
Mina Grande	Pinos Altos	Do.	Sherman	Silver Flat	Do.

NORTH CAROLINA.

Conrad Hill	Near Lexington	Davidson.	Henly Hill	12 miles northwest of Carthage.	Moore.
Crowell	6 miles northeast of Albemarle.	Stanley.	King's Mountain	Near King's Mountain	Cleveland.
Dunn's Mountain	3 miles southeast of Salisbury.	Rowan.	Mann	Griffith Township	Nash.
Ethan Allen	1 mile south of Thomasville	Davidson.	McGinn	Capp's Hill	Mecklenburg.
Eureka	Thomasville	Do.	Rudisill	Sixth	Do.
Fisher & Willis	6 miles south of Greensborough.	Guilford.	Silver Valley	Emmons Township	Davidson.

OREGON.

Buffalo	Granite	Grant.	Rye Valley	Rye Valley	Baker.
California	Silver Creek	Baker.	Sugar Pine	Yank	Josephine.
Conner Creek	Conner Creek	Do.	Tom Payne	Pennhouse	Baker.
Gold Ridge	Burnt Pine	Do.	Virtue		Do.
Monumental	Granite	Grant.			

UTAH.

Abel Proctor	West Mountain	Salt Lake.	Buckland	Little Cottonwood	Salt Lake.
Abbey	Big Cottonwood	Do.	Buena Ventura	Star	Beaver.
Accident	West Mountain	Do.	Buffalo	Little Cottonwood	Salt Lake.
Addie	Uintah	Summit.	Bulldozer	West Mountain	Do.
Agnes	West Mountain	Salt Lake.	Bullion	Tintic	Juab.
Aladdin	do	Do.	Bully Boy	West Mountain	Salt Lake.
Alameda	do	Do.	Burgess	do	Do.
Albino	do	Do.	Burning Moscow	do	Do.
Albion	Little Cottonwood	Do.	Burning Moscow Hill	Star	Beaver.
Alice	do	Do.	Butte	Big Cottonwood	Salt Lake.
Allegan	do	Do.	Captain Jack	Ophir	Tooele.
Allegheny	American Fork	Utah.	Caledonia	West Mountain	Salt Lake.
Alma	Mount Baldy	Salt Lake.	California	Ophir	Tooele.
Alpha	Little Cottonwood	Do.	Do.	Harrisburg or Silver Reef	Washington.
Alturas	Big Cottonwood	Do.	Calumet	Rush Valley	Tooele.
Amazon	West Mountain	Do.	Carbonate	San Francisco	Beaver.
Amanda	Big Cottonwood	Do.	Do.	Big Cottonwood	Salt Lake.
Amelia	West Mountain	Do.	Carrie Lucille	Pine Grove	Beaver.
American Flag	do	Do.	Carrie Steele	Camp Floyd	Tooele.
American Flag No. 2	Ophir	Tooele.	Carisa	Tintic	Juab.
Antelope	Big Cottonwood	Salt Lake.	Casco	West Mountain	Salt Lake.
Do.	Ophir	Tooele.	Catherine	Rush Valley	Tooele.
Apex	West Mountain	Salt Lake.	Cave	Bradshaw	Beaver.
Argent	Rush Valley	Tooele.	Do.	West Mountain	Salt Lake.
Argonaut	West Mountain	Salt Lake.	Cedar	Ophir	Tooele.
Argyle	do	Do.	Centennial	Nebo	Juab.
Arrowpeen	do	Do.	Do.	West Mountain	Salt Lake.
Arthur	Rush Valley	Tooele.	Central Pacific	Weber	Weber.
Ashland	West Mountain	Salt Lake.	Cerro Gordo Consolidated	San Francisco	Beaver.
Austin	Silver Lake	Utah.	Checo	Rush Valley	Tooele.
Azure Queen	Ophir	Tooele.	Champion	Provo	Beaver.
Badger	West Mountain	Salt Lake.	Chattanooga	Ohio	Pi Ute.
Baker	Big Cottonwood	Do.	Chicago	West Mountain	Salt Lake.
Balance	Little Cottonwood	Do.	Do.	Ophir	Tooele.
Banner	Tintic	Juab.	Chicago Tunnel	Little Cottonwood	Salt Lake.
Do	Uintah	Summit.	Chicago and Frisco Con	San Francisco	Beaver.
Barbee & Walker	Harrisburg or Silver Reef	Washington.	Chieftain	Big Cottonwood	Salt Lake.
Barstow	West Mountain	Salt Lake.	Chloride	Ophir	Tooele.
Bazouk	do	Do.	Chloride Chief	Harrisburg or Silver Reef	Washington.
Beecher	Ohio	Pi Ute.	Chloride Gem	Ophir	Tooele.
Belle of Monroe	do	Do.	Chubb	West Mountain	Salt Lake.
Belle of the Vale	do	Do.	Cincinnati	Little Cottonwood	Do.
Bemis	West Mountain	Salt Lake.	Cincinnati No. 1	do	Do.
Benton	do	Do.	Cincinnati No. 2	do	Do.
Bertrand	do	Do.	Cincinnati No. 3	do	Do.
Big Bonanza	Star	Beaver.	City Rock	do	Do.
Bismuth	Granite	Do.	Clara Davis	Uintah	Summit.
Black Bess	Big Cottonwood	Salt Lake.	Cliff	Mount Baldy	Pi Ute.
Black Dragon	Tintic	Juab.	Clipper	Tooele	Tooele.
Black Metallic	West Mountain	Salt Lake.	Clyde	Mount Baldy	Pi Ute.
Black Warrior	Weber	Weber.	Colbath	Big Cottonwood	Salt Lake.
Blue Jay	West Mountain	Salt Lake.	Colorado	West Mountain	Do.
Bobtail	do	Do.	Col. Sellers	do	Do.
Bollis & Collins	Little Cottonwood	Do.	Columbia	do	Do.
Bonanza	Tintic	Juab.	Do.	Ophir	Tooele.
Do.	Tooele	Ophir.	Columbus	Big Cottonwood	Salt Lake.
Bonham	West Mountain	Salt Lake.	Comfort	West Mountain	Do.
Bonnie Blue Flag	do	Do.	Congress	Big Cottonwood	Do.
Boss	Uintah	Summit.	Constitution	West Mountain	Do.
Boulder	Blue Ledge	Wasatch.	Cooper	Big Cottonwood	Do.
Brain Lode	Little Cottonwood	Salt Lake.	Copenhagen	West Mountain	Do.
Bright Point	Big Cottonwood	Do.	Copper Belt	Ohio	Pi Ute.
Brilliant	West Mountain	Do.	Coral Reef	Lincoln	Beaver.
British	Tintic	Juab.	Cottonwood	Rush Valley	Tooele.
British Flag	West Mountain	Salt Lake.	Creedmore	Star	Beaver.
Brooklyn	Ophir	Tooele.	Cricket	Tintic	Juab.
Buckeye	Uintah	Summit.	Crismon-Mammoth	do	Do.
Do.	Harrisburg or Silver Reef	Washington.	Crœsus	Star	Beaver.
Brothern	Ophir	Tooele.	Do.	West Mountain	Salt Lake.

DEEP MINES—Continued.

UTAH—Continued.

Name of claim.	District.	County.
Croff	Tintic	Juab.
Crown Point	Little Cottonwood	Salt Lake.
Crystal	Mount Baldy	Pi Ute.
Crystal Palace	Pine Grove	Beaver.
Cunningham No. 2	Little Cottonwood	Salt Lake.
Damn Fool	West Mountain	Do.
Darlington	Little Cottonwood	Do.
Davenport	do	Do.
December group	Lincoln	Beaver.
Deer Trail	Mount Baldy	Pi Ute.
Defiance	Big Cottonwood	Salt Lake.
Delmonte	Rosebud	Weber.
Dexter Consolidated	Little Cottonwood	Salt Lake.
Deseret	Ophir	Tooele.
Dial	West Mountain	Salt Lake.
Dixie	Harrisburg or Silver Reef	Washington.
Dixon	West Mountain	Salt Lake.
Dixon No. 3	do	Do.
Dodge	Harrisburg or Silver Reef	Washington.
Dolly Varden	Big Cottonwood	Salt Lake.
Dora	West Mountain	Do.
Douglas	Ophir	Tooele.
Duffin	Harrisburg or Silver Reef	Washington.
Eagle	Big Cottonwood	Salt Lake.
Eagle Bird	West Mountain	Do.
East Park M. Co	Blue Ledge	Wasatch.
Eclipse	Big Cottonwood	Salt Lake.
Edison	West Mountain	Do.
Elephant	Star	Beaver.
Do	West Mountain	Salt Lake.
Elgin	Ophir	Tooele.
Elkhorn	Camp Floyd	Do.
Ely	West Mountain	Salt Lake.
Elmer Ray	Tintic	Juab.
Elvina	West Mountain	Salt Lake.
Emily	Little Cottonwood	Do.
Do	West Mountain	Do.
Emily Jane	Harrisburg or Silver Reef	Washington.
Emma	Little Cottonwood	Salt Lake.
Emma May	do	Do.
Empire	Ophir	Tooele.
Emporia	do	Do.
Enterprise	Little Cottonwood	Salt Lake.
Equitable	do	Do.
Equitable No. 2	do	Do.
Essex	West Mountain	Do.
Eureka	Tintic	Juab.
Do	West Mountain	Salt Lake.
Evening Star	Ophir	Tooele.
Evergreen	Little Cottonwood	Salt Lake.
Do	West Mountain	Do.
Excelsior	do	Do.
Do	American Fork	Utah.
Excelsior No. 2	West Mountain	Salt Lake.
Experiment	do	Do.
Extension	do	Do.
Fairview	Big Cottonwood	Do.
Do	Uintah	Summit.
Fannie Bemis	West Mountain	Salt Lake.
Fillmore	Ohio	Pi Ute.
First National	Rush Valley	Tooele.
Flagstaff	Little Cottonwood	Salt Lake.
Flavilla	Ophir	Tooele.
Flora	Star	Beaver.
Fourth of July	Ophir	Tooele.
Fox	West Mountain	Salt Lake.
Frederick	Little Cottonwood	Do.
Freeland	do	Do.
Free Silver Mining Company	Blue Ledge	Wasatch.
Frisco	Big Cottonwood	Salt Lake.
Do	West Mountain	Do.
Frisco Consolidated	San Francisco	Beaver.
Fuller	Little Cottonwood	Salt Lake.
Galena	West Mountain	Do.
Galena Extension	do	Do.
Gem	do	Do.
General Connor	Rush Valley	Tooele.
General Garfield	do	Do.
General Scott	Hot Springs	Salt Lake.
General Washington	Uintah	Summit.
Geneva	Little Cottonwood	Salt Lake.
Geneva Tunnel	do	Do.
George	West Mountain	Do.
Germania	Nebo	Juab.
Giant Chief	West Mountain	Salt Lake.
Gibson	Harrisburg or Silver Reef	Washington.
Gladiator	Little Cottonwood	Salt Lake.
Glencoe	Blue Ledge	Wasatch.
Golden Bell	Tintic	Juab.
Golden Crown	West Mountain	Salt Lake.
Golden Era	Star	Beaver.
Golden Treasure	Tintic	Juab.
Good Hope	Preuss	Beaver.
Grampian	San Francisco	Do.
Grand Cross	West Mountain	Salt Lake.
Granger	Rush Valley	Tooele.
Gray Eagle	Detroit	Millard.
Do	West Mountain	Salt Lake.
Great Basin	Rush Valley	Tooele.
Great Eastern	Uintah	Summit.
Grecian Bend	West Mountain	Salt Lake.
Greeley	do	Do.
Green-eyed Monster	Mount Baldy	Pi Ute.
Do	Ophir	Tooele.
Green Grove	West Mountain	Salt Lake.
Grizzly	Little Cottonwood	Do.
Grosbeck or Emperor	Big Cottonwood	Salt Lake.
Hamlin	West Mountain	Do.
Hannah	Rush Valley	Tooele.
Happy-go-lucky	West Mountain	Salt Lake.
Harriet No. 1	do	Do.
Harriet No. 2	do	Do.
Harriet No. 3	do	Do.
Harriet No. 4	do	Do.
Harrisburg	Star	Beaver.
Hawkeye	Blue Ledge	Wasatch.
Hayes	Big Cottonwood	Salt Lake.
Henrietta	West Mountain	Do.
Henry	Hot Springs	Do.
Henry M	West Mountain	Do.
Hiatt	do	Do.
Hiawatha	Little Cottonwood	Salt Lake.
Hickory	Star	Beaver.
Hidden Treasure	Tintic	Juab.
Do	Ophir	Tooele.
Hidden Treasure E. Ext	do	Do.
Highland	West Mountain	Salt Lake.
Highland Boy	Little Cottonwood	Do.
Do	West Mountain	Do.
Highland Chief	Big Cottonwood	Do.
Do	Little Cottonwood	Do.
Homestake	San Francisco	Beaver.
Do	Ohio	Pi Ute.
Do	Blue Ledge	Wasatch.
Hooper	West Mountain	Salt Lake.
Hoosier Boy	Star	Beaver.
Horn-Silver	San Francisco	Do.
Howard	Detroit	Millard.
Howland	Little Cottonwood	Salt Lake.
Hudson	American Fork	Utah.
Huntington Crandal	Tintic	Juab.
Idaho	West Mountain	Salt Lake.
Illinois	Little Cottonwood	Do.
Imperial	do	Do.
Do	Big Cottonwood	Do.
Income	Star	Beaver.
Ingersoll	West Mountain	Salt Lake.
Ingomar	San Francisco	Beaver.
Irish-American	West Mountain	Salt Lake.
Island	Little Cottonwood	Do.
Ivanhoe	Star	Beaver.
Do	Ophir	Tooele.
I. X. L	West Mountain	Salt Lake.
Do	Ophir	Tooele.
Jasper	Rush Valley	Do.
Jeannette	Uintah	Summit.
Jennie	Ophir	Tooele.
Jersey Blue	West Mountain	Salt Lake.
Jim Fisk, jr	Ophir	Tooele.
Jolly Boy	Bradshaw	Beaver.
Jones' Bonanza	Snake Creek	Wasatch.
Jordan	West Mountain	Salt Lake.
Josephine	Little Cottonwood	Do.
Julian Lane	Tintic	Juab.
June Rose	do	Do.
Jupiter	Big Cottonwood	Salt Lake.
Katharine	Rush Valley	Tooele.
Kearsarge	Ophir	Do.
Kempton	West Mountain	Salt Lake.
Kenosha	Little Cottonwood	Do.
Killian	West Mountain	Do.
King of the West	Little Cottonwood	Do.
Kinner	Harrisburg or Silver Reef	Washington.
Kinsey	Tintic	Juab.
Knickerbocker	West Mountain	Salt Lake.
Lady Aspinwall	Tintic	Juab.
Lady Emma	Little Cottonwood	Salt Lake.
Lady Franklin	Weber	Weber.
Lady of the Lake	Blue Ledge	Wasatch.
Last Chance	Little Cottonwood	Salt Lake.
Do	West Mountain	Do.
Do	Uintah	Summit.
Do	Camp Floyd	Tooele.
Do	Harrisburg or Silver Reef	Washington.
Last Chance No. 2	West Mountain	Salt Lake.
Lavinia	Little Cottonwood	Do.
Lawrence	Hot Springs	Do.
Do	West Mountain	Do.
Lead	do	Do.
Leeds	Harrisburg or Silver Reef	Washington.
Legal Tender	Rush Valley	Tooele.
Lenora	do	Do.
Leontine	Little Cottonwood	Salt Lake.
Levant	West Mountain	Do.
Liberty	do	Do.
Lion	Rush Valley	Tooele.
Do	Ophir	Do.
Little Cora	Big Cottonwood	Salt Lake.
Little Giant	do	Do.
Do	Blue Ledge	Wasatch.
Little Mac	Uintah	Summit.
Little Mattie	West Mountain	Salt Lake.
Live Pine	do	Do.
Live Yankee	American Fork	Utah.
Do	West Mountain	Salt Lake.
Lone Pine	Big Cottonwood	Do.
Lorenzo	West Mountain	Do.
Louise	Little Cottonwood	Do.
Lucky	Tintic	Juab.
Lucky Boy	Mount Baldy	Pi Ute.
Madeira Consolidated	Big Cottonwood	Salt Lake.
Maggie	Harrisburg or Silver Reef	Washington.

DEEP MINES—Continued.

UTAH—Continued.

Name of claim.	District.	County.
Magnolia	Ophir	Tooele.
Mahogany	do	Do.
Makalola	San Francisco	Beaver.
Mammoth	Star	Do.
Do	Detroit	Millard.
Mammoth-Copperopolis	Tintic	Juab.
Mammoth-Eureka	do	Do.
Manhattan	Harrisburg or Silver Reef	Washington.
Manitoba	Little Cottonwood	Salt Lake.
Maple Tree	West Mountain	Do.
Marco	Tintic	Juab.
Marion	Little Cottonwood	Salt Lake.
Do	Camp Floyd	Tooele.
Marsac	Uintah	Summit.
Mary Ellen	American Fork	Utah.
Maud	Harrisburg or Silver Reef	Washington.
Maxfield	Big Cottonwood	Salt Lake.
Maybell	Rush Valley	Tooele.
Mayflower	West Mountain	Salt Lake.
Do	Rose Bud	Weber.
McHenry	Blue Ledge	Wasatch.
McKay	Little Cottonwood	Salt Lake.
McNally	Harrisburg or Silver Reef	Washington.
Merwin	Rush Valley	Tooele.
Middle Belt	do	Do.
Midway	Camp Floyd	Do.
Milkmaid	Silver Lake	Utah.
Mill City	West Mountain	Salt Lake.
Miller	do	Do.
Do	American Fork	Utah.
Milwaukee	Tintic	Juab.
Mineral Point	West Mountain	Salt Lake.
Miner's Delight	Ophir	Tooele.
Miner's Dream	Star	Beaver.
Do	West Mountain	Salt Lake.
Mohawk	Ohio	Pi Ute.
Monarch	Ophir	Tooele.
Monarch No. 2	do	Do.
Monarch No. 3	do	Do.
Monitor	Star	Beaver.
Do	Uintah	Summit.
Mono	Ophir	Tooele.
Montana	Tintic	Juab.
Do	West Mountain	Salt Lake.
Monte del Rey	Mount Baldy	Pi Ute.
Montezuma	Little Cottonwood	Salt Lake.
Montreal	West Mountain	Do.
Mountaineer	Star	Beaver.
Mountain Gem	Ophir	Tooele.
Mountain Maid	Bradshaw	Beaver.
Do	West Mountain	Salt Lake.
Mountain Queen	Nebo	Juab.
Mountain Savage	Ophir	Tooele.
Mountain Tiger	do	Do.
Mormon Chief	Camp Floyd	Do.
Mormon Nell	West Mountain	Salt Lake.
Morning Glory	Tintic	Juab.
Morning Star	Ohio	Pi Ute.
Muscatine	Rush Valley	Tooele.
Nabob	Little Cottonwood	Salt Lake.
Nast	West Mountain	Do.
Nebraska	Silver Lake	Utah.
Neptune	West Mountain	Salt Lake.
New Bedford	Snake Creek	Wasatch.
New Compromise	American Fork	Utah.
Nez Percés Chief	West Mountain	Salt Lake.
Nip-and-Tuck	Bradshaw	Beaver.
North Pole	Little Cottonwood	Salt Lake.
North Side	San Francisco	Beaver.
North Star	Tintic	Juab.
Do	Little Cottonwood	Salt Lake.
Do	West Mountain	Do.
Northern Belt	Rush Valley	Tooele.
Northern Chief	West Mountain	Salt Lake.
Northern Light	do	Do.
Noyes	Ophir	Tooele.
No you don't	West Mountain	Salt Lake.
Do	Rush Valley	Tooele.
Number Six	West Mountain	Salt Lake.
Old Stand By	do	Do.
Old Telegraph	do	Do.
Olive Branch	Nebo	Juab.
Olympia	West Mountain	Salt Lake.
Omaha	do	Do.
Ontario	Uintah	Summit.
Orphan	American Fork	Utah.
Orphir	Big Cottonwood	Salt Lake.
Oregon	do	Salt Lake.
Orphan Boy	West Mountain	Do.
Osage	do	Do.
Osceola	Star	Beaver.
Do	Big Cottonwood	Salt Lake.
Do	Grantsville	Tooele.
Overland	Big Cottonwood	Salt Lake.
Do	West Mountain	Do.
Oxford	Little Cottonwood	Do.
Park	Tintic	Juab.
Park City	Uintah	Salt Lake.
Parker	West Mountain	Do.
Pat	Little Cottonwood	Summit.
Peabody	West Mountain	Do.
Phœnix	do	Do.
Pinafore	Pine Grove	Beaver.
Pinkham	Harrisburg or Silver Reef	Washington.
Pitou	Uintah	Summit.
Pioneer	Snake Creek	Wasatch.
Pittsburgh	American Fork	Utah.
Plata de Mina	Mount Baldy	Pi Ute.
Pluto	do	Do.
Pocatello	Blue Ledge	Wasatch.
Poorman	Ophir	Tooele.
Prince of Wales	Big Cottonwood	Salt Lake.
Do	West Mountain	Do.
Promontory	Bradshaw	Beaver.
Paterhaugh	Big Cottonwood	Salt Lake.
Putnam	Rush Valley	Tooele.
Quaking Asp	West Mountain	Salt Lake.
Quandary No. 2	Rush Valley	Tooele.
Queen	West Mountain	Salt Lake.
Queen of the Hill	Ophir	Tooele.
Queen of the West	American Fork	Utah.
Rattler	San Francisco	Beaver.
Do	Ophir	Tooele.
Rebel	Star	Beaver.
Red Cloud	West Mountain	Salt Lake.
Red Line	Ophir	Tooele.
Red Pine	Big Cottonwood	Salt Lake.
Red Rover	West Mountain	Do.
Reed & Benson	Big Cottonwood	Do.
Reliable	Bradshaw	Beaver.
Reno Consolidated	Camp Floyd	Tooele.
Revere	West Mountain	Salt Lake.
Revolution	Little Cottonwood	Do.
Richmond	Lincoln	Beaver.
Do	Big Cottonwood	Salt Lake.
Rising Sun	Tintic	Juab.
Do	Little Cottonwood	Salt Lake.
Rob Roy	Tooele	Tooele.
Rockwell	Ophir	Do.
Rollins	Lincoln	Beaver.
Roman Empire	West Mountain	Salt Lake.
Rough and Ready	Little Cottonwood	Do.
Do	West Mountain	Do.
Rothschild	Mount Baldy	Pi Ute.
Rustler	Star	Beaver.
Do	American Fork	Utah.
Sacramento	West Mountain	Salt Lake.
Do	Ophir	Tooele.
Sacred	West Mountain	Salt Lake.
Saginaw	do	Do.
Sailor Jack	Big Cottonwood	Do.
Saint James	West Mountain	Do.
Saint John	do	Do.
Saint Louis	Ophir	Tooele.
Saint Mark's	West Mountain	Salt Lake.
Saint Mary's	Star	Beaver.
Salt Lake	West Mountain	Salt Lake.
Sampson	Big Cottonwood	Do.
Do	Uintah	Summit.
Sanders	West Mountain	Salt Lake.
San Joaquin	Ophir	Tooele.
Saratoga	West Mountain	Salt Lake.
Saturn	do	Do.
Savage	Star	Beaver.
Do	Little Cottonwood	Salt Lake.
Do	West Mountain	Do.
S. and S.	do	Do.
Scotia	West Tintic	Juab.
Sedan	Little Cottonwood	Salt Lake.
Shell	West Mountain	Do.
Shoo Fly	Ophir	Tooele.
Shower	Tintic	Juab.
Silver Bell	American Fork	Utah.
Silver Chief	Ophir	Tooele.
Silver Circle	Camp Floyd	Do.
Silver Crown	Harrisburg or Silver Reef	Washington.
Silver Flat	American Fork	Utah.
Do	Harrisburg or Silver Reef	Washington.
Silver Hill	Prouse	Beaver.
Do	West Mountain	Salt Lake.
Silver King	Ohio	Pi Ute.
Silver King No. 1	Rush Valley	Tooele.
Silver King W. Ext	do	Do.
Silver Mountain	Big Cottonwood	Salt Lake.
Silver Plume	West Mountain	Do.
Silver Point	Harrisburg or Silver Reef	Washington.
Silver Queen	Rush Valley	Tooele.
Silver Reef	Rose Bud	Weber.
Silver Shield	Little Cottonwood	Salt Lake.
Do	West Mountain	Do.
Silver Spar	Tintic	Juab.
Sinkiyou	Little Cottonwood	Salt Lake.
Southport	Rush Valley	Tooele.
South Side	San Francisco	Beaver.
South Star	Little Cottonwood	Salt Lake.
Spanish	West Mountain	Do.
Sparrow Head	Camp Floyd	Tooele.
Stanley	West Mountain	Salt Lake.
Star of the West	Camp Floyd	Tooele.
Steamboat	West Mountain	Salt Lake.
Stepmother	San Francisco	Beaver.
Stewart	West Mountain	Salt Lake.
Stewart No. 2	do	Do.
Stewart Fractional No. 2	do	Do.
Stormont	Harrisburg or Silver Leaf	Washington.
Story	West Mountain	Salt Lake.
Summit	San Francisco	Beaver.
Do	West Mountain	Salt Lake.
Do	Ophir	Tooele.
Sunbeam	Tintic	Juab.
Sunbeam No. 1	do	Do.
Sunday	American Fork	Utah.

DEEP MINES—Continued.

UTAH—Continued.

Name of claim.	District.	County.	Name of claim.	District.	County.
Sundown	West Mountain	Salt Lake.	Venice	West Mountain	Salt Lake.
Sunnyside	Ophir	Tooele.	Vespasian	do	Do.
Sunset	West Mountain	Salt Lake.	Veto	do	Do.
Surprise	do	Do.	Vicksburg	Star	Beaver.
Susan	Tintic	Juab.	Victor	West Mountain	Salt Lake.
Swansea	do	Do.	Victoria	Little Cottonwood	Do.
Switzerland	Uintah	Summit.	Virginia	do	Do.
Talco Consolidated	Rosebud	Weber.	Vulcan	Star	Beaver.
Taylor	Big Cottonwood	Salt Lake.	Do	West Mountain	Salt Lake.
Tecumseh	Harrisburg or Silver Reef	Washington.	Do	Rush Valley	Tooele.
Telegraph	West Mountain	Salt Lake.	Wade Hampton	do	Do.
Telegraph first W. Ext	do	Do.	Walker	Uintah	Summit.
Telegraph third W. Ext	do	Do.	Wandering Boy	Big Cottonwood	Salt Lake.
Ten-Forty	do	Do.	Wandering Jew	Ophir	Tooele.
Tesora	Tintic	Juab.	War Eagle	Uintah	Summit.
Thad. Stevens	Ophir	Tooele.	Do	American Fork	Utah.
Theresa	Big Cottonwood	Salt Lake.	Warrior	Big Cottonwood	Salt Lake.
Third Term	Grantsville	Tooele.	Wasatch	West Mountain	Do.
Thompson	Harrisburg or Silver Reef	Washington.	Do	Blue Ledge	Wasatch.
Thompson Consolidated	Rosebud	Weber.	Wasatch King	Silver Lake	Utah.
Thor	Big Cottonwood	Salt Lake.	Wasco	Star	Beaver.
Thrush	West Mountain	Do.	Washington	West Mountain	Salt Lake.
Tiewaukee	do	Do.	Webster	Ohio	Pi Ute.
Tilden	do	Do.	Wedge	West Mountain	Salt Lake.
Tiney	Uintah	Summit.	Wellington	Big Cottonwood	Do.
Titus	Little Cottonwood	Salt Lake.	Wendigo	Tintic	Juab.
Tecquerville	Harrisburg or Silver Reef	Washington.	Weston	Ophir	Tooele.
Toledo	Little Cottonwood	Salt Lake.	West Wind	Little Cottonwood	Salt Lake.
Torpedo	West Mountain	Do.	Whirlwind	American Fork	Utah.
Trace	Ophir	Tooele.	White Pine	Uintah	Summit.
Treasure	American Fork	Utah.	Wild Bill	Star	Beaver.
Twombly	Tintic	Juab.	Wild Dutchman	American Fork	Utah.
Tyler	Big Cottonwood	Salt Lake.	Wild Rose	Tintic	Juab.
Uncle Sam	Mount Baldy	Pi Ute.	Williams	West Mountain	Salt Lake.
Undine	Tintic	Juab.	Williams & Lowell	Blue Ledge	Wasatch.
Union Fing	West Mountain	Salt Lake.	Winnamuck	West Mountain	Salt Lake.
Utah	Little Cottonwood	Do.	Do	do	Do.
Do	West Mountain	Do.	Woodside	Uintah	Summit.
Do	Snake Creek	Wasatch.	Woodman	Tintic	Juab.
Utah No. 2	Little Cottonwood	Salt Lake.	Yampa No. 1	West Mountain	Salt Lake.
Utah No. 3	do	Do.	Yampa No. 2	do	Do.
Utah Consolidated	American Fork	Utah.	Yellow Jacket	San Francisco	Beaver.
Utah Queen	Ophir	Tooele.	York	West Mountain	Salt Lake.
V	Big Cottonwood	Salt Lake.	Yosemite	do	Do.
Vallejo	Little Cottonwood	Do.	Do	do	Do.
Vanderbilt	Harrisburg or Silver Reef	Washington.	Yula	Lincoln	Beaver.
Do	West Mountain	Salt Lake.	Zella	Ophir	Tooele.

VIRGINIA.

Culpeper	18 miles west of Fredericksburg	Culpeper.	Luce Bros	Coohoo	Louisa.
Kelley	7 miles from Rappahannock	Fauquier.	Morrow	Curdsville	Buckingham.
			Rappahannock	Hartford	Stafford.

WASHINGTON.

Shaffer	Peshaston	Yakima.			

WYOMING.

American	California	Sweetwater.	Mary Ellen	California	Sweetwater.
Buckeye State	do	Do.	Miner's Delight	Miner's Delight	Do.
Cariboo	do	Do.	Seg. Miner's Delight	do	Do.
Carlso	Shoshone	Do.	Sydney Johnson	Shoshone	Do.
Hartley	Miner's Delight	Do.	Victoria	California	Do.
Manchester	California	Do.	Yellow Jacket	Shoshone	Do.

AMALGAMATING MILLS.

ARIZONA.

Name of mill.	District.	County.	Name of mill.	District.	County.
Arivaca	Arivaca	Pima.	Isabella	Globe	Pinal.
Bradshaw Basin	Pine Grove	Yavapai.	McCracken	Owens	Mohave.
Central Arizona	Town of Vulture	Maricopa.	Do	do	Do.
Champion	Globe	Do.	Mineral Park	Hualapai	Do.
Contention	Tombstone	Pima.	Peabody	Owens	Do.
Corbin	do	Do.	Peck	Peck	Yavapai.
Derré & Townsend	Arivaca	Do.	Signal	Owens	Mohave.
Gird	Tombstone	Do.	Silver King	Pioneer	Pinal.
Golden Era	Cherry Creek	Yavapai.	Stonewall Jackson	Globe	Maricopa.
Grounds & Welton	Hualapai	Mohave.	Tiger	Tiger	Yavapai.
Hampden	Cedar Valley	Do.	Tip Top	do	Do.
Do	do	Do.	Windsor	Cherry Creek	Do.

CALIFORNIA.

Afterthought		Shasta.	Black Bear	South Fork Salmon	Siskiyou.
Alabama	Jamestown	Tuolumne.	Bodie	Bodie	Mono.
Amelia	Washington	Calaveras.	Brown Monster	Russ	Inyo.
Arizona Northern Company	Hualapai	Mohave.	Brush Hill	Hayden Hill	Lassen.
Bidwell	Clark	San Bernardino.	Buck & Settler	Julian	San Diego.

AMALGAMATING MILLS—Continued.

CALIFORNIA—Continued.

Name of mill.	District.	County.	Name of mill.	District.	County.
Bullion	Mariposa Estate	Mariposa.	McNulty	Near Placerville	El Dorado.
Bulwer-Standard	Bodie	Mono.	Mellones	Robinson's Ferry	Calaveras.
Chaparral	Near Kelsey	El Dorado.	Minera	Bodie	Mono.
Chicago		Shasta.	Minletta Belle	Lookout	Inyo.
Commanche		Mono.	Monitor Consolidated	Indian Valley	Plumas.
Consolidated Amador	Sutter Creek	Amador.	Monte Christo	Jackson	Amador.
Confidence	Confidence	Tuolumne.	Monte Richard	do	Do.
Copper City	Pittsburgh	Shasta.	Murchie	Nevada City	Nevada.
Diana	Blind Spring	Mono.	Nevada City	do	Do.
Dolan & Cogswell	Near Angel's	Calaveras.	New Albany	Summerville	Tuolumne.
Downe	Volcano	Amador.	Noonday	Bodie	Mono.
			Oneida	Jackson	Amador.
Empire	Sutter Creek	Amador.	Original Amador	Amador City	Do.
Fegus	Volcano	Do.	Panamint	Panamint	Inyo.
Genesee	Genesee Valley	Placer.	Peabody	Aurora	San Diego.
Gold Stripe	Indian Valley	Plumas.	Picacho	Picacho	Do.
Golden Chariot	Banner	San Diego.	Placerville	Placerville	Eldorado.
Golden Eagle	Hayden Hill	Lassen.	Plumas-Eureka	Quartz Township	Plumas.
Golden Gate	Volcano	Amador.	Plumas-National	Indian Valley	Do.
Green Mountain	Indian Valley	Plumas.	Pool	Hornitos	Mariposa.
Gwin	Mokelumne Hill	Calaveras.	Providence	Nevada City	Nevada.
Harris	Independence	Do.	Rising Sun	Colfax	Placer.
Do.	Jamestown	Tuolumne.	Roseberry & Knight	Hayden Hill	Lassen.
Hite	Mariposa Estate	Mariposa.	Savercool	Seneca	Plumas.
Homer	Homer	Mono.	Soulsby	Soulsbyville	Tuolumne.
Hubbard	Banner	San Diego.	Spaulding	Bodie	Mono.
Idaho	Grass Valley	Nevada.	Springfield	Springfield	El Dorado.
Ivanpah	Clark	San Bernardino.	Standard	Bodie	Mono.
Johnson	Quartz Valley	Siskiyou.	Syndicate	do	Do.
Kearsarge	Kearsarge	Inyo.	Tower	Indian	Do.
Kelly	Riverside	Tuolumne.	True Gold	Placerville	El Dorado.
Keystone Consolidated	Amador City	Amador.	Washington	Hornitos	Mariposa.
Klamath	Sawyer's Bar	Siskiyou.	Whisky Slide	Mokelumne Hill	Calaveras.
Louisiana	Cherokee	Tuolumne.	Yosemite	Hornitos	Mariposa.
Lyon Gravel	Placerville	El Dorado.	Yuma	Cargo Muchacho	San Diego.
Mad Ox	Whisky Creek	Shasta.	Zelle	Jackson	Amador.

COLORADO.

Adelia	Hardscrabble	Custer.	Kansas	Nevada	Gilpin.
Albro	Morris	Clear Creek.	Kimber & Fullerton	Enterprise	Do.
Black Hawk	Gregory	Gilpin.	Little Annie	Summit	Rio Grande.
Bostwick	Enterprise	Do.	Neikerk	Gold Hill	Boulder.
Boulder	Salina	Boulder.	New York	Gregory	Gilpin.
Caribou	Grand Island	Do.	New York and Colorado	do	Do.
Cashier	Gregory	Gilpin.	Niwot	Ward	Boulder.
Chicago and Colorado	Ward	Boulder.	Pioneer	Upper Union	Clear Creek.
Clayton	Nevada	Gilpin.	Polar Star	Enterprise	Gilpin.
Clear Creek	Griffith	Clear Creek.	Randolph	Gregory	Do.
Colorado Prince	California	Lake.	Sinsendorfer	Enterprise	Do.
Elyria	Avalanche	Summit.	Sullivan & Wheeler	do	Do.
Empire	Enterprise	Gilpin.	Trojan	Idaho	Clear Creek.
Farwell	Griffith	Clear Creek.	United Gregory	Gregory	Gilpin.
Golden Age	Central	Boulder.	Upper Kimber & Fullerton	Enterprise	Do.
Humphreys	Enterprise	Gilpin.	Waterman	Eureka	Do.
John Jay		Boulder.	Whitcomb	Nevada	Do.

DAKOTA.

A. P. Moore	Whitewood	Lawrence.	Golden Star	Whitewood	Lawrence.
Caledonia	do	Do.	Golden Terra (20-stamp)	do	Do.
Central	do	Do.	Golden Terra (40-stamp)		Do.
Champion	do	Do.	Great Eastern	Whitewood	Do.
Deadwood	do	Do.	Hidden Treasure	do	Do.
Dr. Thompson	do	Do.	Highland	do	Do.
Elliot	do	Do.	Homestake	do	Do.
Fairview	do	Do.	McLaughin & Cassell	do	Do.
Father de Smet	Lost Placer	Do.	Milwaukee and Black Hills	do	Do.
Foot Hildebrandt	Whitewood	Do.	Racine	do	Do.
Florence	Bear Butte	Do.	Union	do	Do.

GEORGIA.

Barlow	Twelfth	Lumpkin.	J. B. Smith	Bussey	Wilkes.
Bast	do	Do.	Jennings	Republican	McDuffie.
Blake	Fourth	White.	Kendall	One hundred and seventy-eighth.	Wilkes.
Cheyanagowah		Cherokee.			
Cleveland	Thirteenth	Lumpkin.	Kendrick		Cobb.
Dahlonega	Twelfth	Do.	Lockhart	Twelfth	Lumpkin.
Findley (steam)	do	Do.	Morgan	Gainston	Oglethorpe.
Findley (water)	do	Do.	Nacoochee	Third	White.
Georgia	Ninth	Hall.	Parks	do	Cherokee.
Griscom	Twelfth	Lumpkin.	Sales	Goshen	Lincoln.
Harris	Ninth	Hall.	Singleton	Twelfth	Lumpkin.
Hayden	do	Do.	Stoney Ridge		Wilkes.
Holland	Eighth	Haralson.	Strickland	Third	Forsyth.
Ivy	Twelfth	Lumpkin.			

IDAHO.

Bonaparte Consolidated (old)	Bonaparte	Alturas.	Davis	Middle Boisé	Alturas.
Bonaparte Consolidated (new)	do	Do.	Elkhorn	Elkhorn	Boisé.
Buffalo	Middle Boisé	Do.	Elmira	Banner	Do.
Buffalo and Atlanta	do	Do.	Elmore	Rocky Bar	Alturas.
Cosmos or Silver Cord	Carson	Owyhee.	do	Carson	Owyhee.

AMALGAMATING MILLS—Continued.

IDAHO—Continued.

Name of mill.	District.	County.	Name of mill.	District.	County.
Gen. Custer	Yankee Fork	Lemhi.	New York or Golden Chariot	Carson	Owyhee.
Gold Hill	Granite	Boisé.	Plowman	Shaw's Mountain	Boisé.
Greenback	Middle Boisé	Alturas.	Reeser	Rocky Bar	Alturas.
Iowa	Granite	Boisé.	Rescue	Warren's	Idaho.
Joe Daly	Queen's River	Alturas.	Scales & Wagner	Carson	Owyhee.
Jones & Adams	Wagontown	Owyhee.	South Chariot	do	Do.
King	Mammoth	Boisé.	Sub Rosa	Gambrinus	Boisé.
Leonard	Carson	Owyhee.	Tremont	Wagontown	Owyhee.
Mammoth	Mammoth	Boisé.	Victor	Red Warrier	Alturas.
Mattingly	Middle Boisé	Alturas.	Wide West	do	Do.
Monarch	do	Do.			

MAINE.

Sullivan	Sullivan	Hancock			

MONTANA.

Algonquin	Flint Creek	Deer Lodge.	Hope	Flint Creek	Deer Lodge.
Alice	Summit Valley	Do.	Hursts & Olds	Hot Springs	Madison.
Belmont	Silver Creek	Lewis and Clarke.	Iron Rod	Silver Star	Do.
Bonanza Chief	Near Helena	Jefferson.	Keating	Cedar Plain	Jefferson.
Burlington	Summit Valley	Deer Lodge.	Lexington	Summit Valley	Deer Lodge.
Carhart	Bannock	Beaver Head.	Mallory	Mineral Hill	Madison.
Clipper	Summit Valley	Deer Lodge.	McLeod, Conly & Murphy	McClellan Gulch	Deer Lodge.
Dexter	do	Do.	Mount Pleasant	Stemple	Lewis and Clarke.
Drumlommond	Stemple	Lewis and Clarke.	Penobscot and Snowdrift	Silver Creek	Deer Lodge.
Elkhorn	Bald Mountain	Beaver Head.	Sheenon's	Bannock	Beaver Head.
Grove Gulch	Summit Valley	Deer Lodge.	Silver Bow	Summit Valley	Deer Lodge.
Heineman	Silver Star	Madison.	Thornton	do	Do.
Holbock	Elkhorn	Jefferson.	Whippoorwill	Stemple	Lewis and Clarke.

NEVADA.

Alexander	Union	Nye.	Manhattan	Reese River	Lander.
Bacon	The Comstock	Lyon.	Mariposa	The Comstock	Storey.
Blue Jacket	Blue Jacket	Elko.	Martin White	Ward	White Pine.
Boston	The Comstock	Lyon.	Meadow Valley	Ely	Lincoln.
Brunswick	do	Ormsby.	Morey	Morey	Nye.
Bullion of Paradise	Mount Rose	Humboldt.	Morgan	The Comstock	Ormsby.
California	The Comstock	Storey.	Nevada	do	Storey.
Cambridge	Cambridge	Esmeralda.	Northern Belle No. 1	Columbus	Esmeralda.
Central	Pine Grove	Do.	Northern Belle No. 2	do	Do.
Columbia Consolidated	Columbia	Elko.	Occidental	The Comstock	Lyon.
Consolidated Virginia	The Comstock	Storey.	Omega	do	Storey.
Dayton	do	Lyon.	Pacific	do	Lyon.
Dolores	Pine Grove	Esmeralda.	Paradise Valley	Mount Rose	Humboldt.
Douglass	The Comstock	Lyon.	Pioneer	Pine Grove	Esmeralda.
Eberhardt and Aurora	White Pine	White Pine.	Rhode Island	The Comstock	Storey.
Empire State	The Comstock	Storey.	Santiago	do	Ormsby.
Endowment	Black Mountain	Esmeralda.	Southwestern	El Dorado	Lincoln.
Eureka	The Comstock	Lyon.	Star	Cherry Creek	White Pine.
Fairmount	Winnemucca	Humboldt.	Starr & Grove	Lewis	Lander.
Foundry	Esmeralda	Esmeralda.	Trench	The Comstock	Lyon.
Gen. Thomas	Columbus	Do.	Tybo	Tybo	Nye.
Grand Prize	Tuscarora	Elko.	Valley	Pahranagat	Lincoln.
Humboldt	Winnemucca	Humboldt.	Vivian	The Comstock	Ormsby.
Independence-Navajo	Tuscarora	Elko.	Wenban	Cortes	Eureka.
Indian Queen	Oneota	Esmeralda.	Wheeler	Wilson	Esmeralda.
Lancaster	Tuscarora	Elko.	Wilson	do	Do.
Lang Syne	Sierra	Humboldt.	Winfield	The Comstock	Storey.
Leopard	Cornucopia	Elko.	Woodworth	do	Lyon.
Ledi	Silver Peak	Esmeralda.			

NEW MEXICO.

Bremen	Silver Flat	Grant.	Miembres	Miembres	Grant.
Cosette	do	Do.	Weeks & Fresh	Hillsborough	Doña Ana.

NORTH CAROLINA.

Fisher & Willis Hill		Guilford.	McGinn	Capp's Hill	Mecklenburg.
Huston		Moore.	New York and North Carolina	Near Charlotte	Do.
King's Mountain		Gaston.	Rudisill	Sixth Congressional	Do.

OREGON.

Conner Creek	Conner Creek	Baker.	Rye Valley	Rye Valley	Baker.
Gold Ridge	Burnt River	Do.	Virtue	Near Baker City	Do.
Monumental	Granite	Grant.	Wood & Esterbrook	Burnt River	Do.

SOUTH CAROLINA.

Halle	Sixth Judicial	Lancaster.			

AMALGAMATING MILLS—Continued.

UTAH.

Name of mill.	District.	County.	Name of mill.	District.	County.
Baltic	Rush Valley	Tooele.	Mammoth-Copperopolis	Tintic	Juab.
Barbee & Walker	Harrisburg or Silver Reef	Washington.	Marsac	Uintah	Summit.
Carrie Steele	Camp Floyd	Tooele.	McHenry	Park City	
Christy	Harrisburg or Silver Reef	Washington.	Milford	Milford	
Crismon-Mammoth	Tintic	Juab.	North Star		Beaver.
Durant			Ontario	Uintah	Summit.
Ely	Tintic	Salt Lake.	Stewart No. 1	West Mountain	Salt Lake.
Jordan (10 stamp)	West Mountain	Do.	Stewart No. 2	do	Do.
Jordan (60 stamp)	do	Do.	Stormont	Harrisburg or Silver Reef	Washington.
Leeds	Harrisburg or Silver Reef	Washington.	Tintic	Tintic	Utah.

VIRGINIA.

Culpeper		Culpeper.	Morrow	Cardsville	Buckingham.
Kelly		Fauquier.	Rappahannock	Hartwood	Stafford.
Luce Brothers	Cooboo	Louisa.			

WYOMING.

American	California	Sweetwater.	Keystone	Douglass	Carbon.
Buckeye State	do	Do.	Miner's Delight	Miner's Delight	Sweetwater.
Caribou	do	Do.	N. L. Turner	California	Do.
Hartley	Miner's Delight	Do.	Sec. Miner's Delight	Miner's Delight	Do.
Huff & Ansell	California	Do.	Victor	California	Do.

ARRASTRAS.

ALABAMA.

Name of mill.	District.	County.	Name of mill.	District.	County.
Houston & Pinson	Thirty-third	Cleburne.			

ARIZONA.

Gross & Smith	Hualapai	Mohave.	South Ore Belle	Tiger	Yavapai.
Johnson	Weaver	Yavapai.	Thunderbolt	Walker	Do.
Nash		Do.			

CALIFORNIA.

Champion	Independence	Calaveras.	Leper, Keyes & Co	Angel's	Calaveras.
Fresno Enterprise	Potter Ridge	Fresno.	Potter	do	Do.
Italian		Plumas.			

COLORADO.

George Bacheldor	Colorado	Boulder.	Rock Point	Iron Springs	Ouray.

IDAHO.

Estes	Yankee Fork	Lemhi.	Scales & Wagner	Carson	Owyhee.
Lowa	Granite	Boise.	Trask	do	Do.
Norton's	Yankee Fork	Lemhi.			

MONTANA.

Black Tail	Black Tail	Deer Lodge.	H. Siegwhrist	Silver Star	Madison.
Glen Egbert		Do.	Schafer	Ore Pine Gulch	Lewis and Clarke.

NEVADA.

Chandler	Gold Hill	Storey.	Willis		Esmeralda.

NEW MEXICO.

Skillicorns	Pinos Altos	Grant.			

NORTH CAROLINA.

Mann	Griffith Township	Nash			

ARRASTRAS—Continued.

OREGON.

Name of mill.	District.	County.	Name of mill.	District.	County.
Beagle	Granite	Grant.	Sugar Pine	Yank	Josephine.
McCord	Chicken Creek	Baker.			

WASHINGTON.

Cooper & Lockwood	Peshastan	Yakima.	Wiler & Miller	Peshastan	Yakima.
Shaffer	do	Do.			

SMELTING WORKS.

ARIZONA.

Name of works.	District.	County.	Name of works.	District.	County.
Agua Fria	Big Bug	Yavapai.			

CALIFORNIA.

Defiance	Coso	Inyo.	Union Consolidated	Cerro Gordo	Inyo.
Modock	Lookout	Do.			

COLORADO.

American	California	Lake.	Little Chief	California	Lake.
Boston and Colorado	Argo	Arapahoe.	Lizzie	do	Do.
Boyd		Boulder.	Lincoln City	Avalanche	Summit.
California	California	Lake.	Malta	California	Lake.
Crooks	Galena	Hinsdale.	Moore	Golden City	Jefferson.
Cummings & Finn	California	Lake.	Norfolk and Oursy	Uncompahgre	Ouray.
Duquesne	Sacramento	Park.	Ocean Wave	Lake	Hinsdale.
Elgin	California	Lake.	Ohio and Missouri	California	Lake.
French	Golden City	Jefferson.	Pueblo	Pueblo City	Pueblo.
Gage, Hageman & Co	California	Lake.	Raymond, Sherman & McKay	California	Lake.
Grant	do	Do.	San Juan and New York	Animas	San Juan.
Golden	Golden City	Jefferson.	Utah	California	Lake.
Harrison	California	Lake.	Windham	Uncompahgre	Ouray.
La Plata	do	Do.			

DAKOTA.

El Refugio	Bear Butte	Lawrence.			

IDAHO.

Bay Horse		Lemhi.			

MONTANA.

Alta Montana	Colorado	Jefferson.	Colorado and Montana	Summit Valley	Deer Lodge.

NEBRASKA.

Omaha	Omaha	Douglass.			

NEVADA.

Eureka Consolidated	Eureka	Eureka.	Richmond	Eureka	Eureka.
Hillside	Bristol	Lincoln.			

UTAH.

Chicago	Slagtown	Tooele.	Old Telegraph	West Mountain	Salt Lake.
Flagstaff		Salt Lake.	Park City	Uintah	Summit.
Frisco	San Francisco	Beaver.	Riverside	Star	Beaver.
Germania		Salt Lake.	Shaumtie	do	Do.
Great Basin	Slagtown	Tooele.	Troy	do	Do.
Horn-Silver	San Francisco	Beaver.	Warm Springs		Salt Lake.
Mingo		Salt Lake.	Waterman	Slagtown	Tooele.
Morgan		Do.	Williams & Latey	Star	Beaver.
Old Sultana	American Fork	Utah.			

PLACER MINES.

ARIZONA.

Name of mine.	District.	County.	Name of mine.	District.	County.
Boston	Greenlee Gold Mountain	Apache.	Jackson	8 miles northwest of Prescott	Yavapai.

CALIFORNIA.

A. B. C	Callahan's Ranch	Siskiyou.	La Grange	La Grange	Stanislaus.
Alpha	Nevada	Nevada.	Lennet Brothers	Oak Bar	Siskiyou.
American	Fortwine	Sierra.	Lewiston	Junction City	Trinity.
Do	Sebastopol	Nevada.	Liberty Consolidated	Little York	Nevada.
Bald Mountain	Forest City	Sierra.	Lincoln, Hart & Henry	McAdams Creek	Siskiyou.
Ballarat	North Bloomfield	Nevada.	Little Grizzly	Poker Flat	Sierra.
Baughart	Whisky Creek	Shasta.	Little Kanesbaw	Cherokee Flat	Butte.
Barker	Dutch Flat	Placer.	Little York	Little York	Nevada.
Barton & Co	Oak Bar	Siskiyou.	Lowden & Bates	Lewiston	Trinity.
Bay City	Indian Creek	Do.	Lyon Gravel	Placerville	El Dorado
Berger	Cañon Creek	Trinity.	Mabies Bench	Weaver	Trinity.
Big Bend Klamath	Scott Bar	Siskiyou.	Mackerel Back	Washington	Nevada.
Black Hawk	Near Quincy	Plumas.	Magalia	Magalia	Butte.
Blakely	Placerville	El Dorado.	Mammoth	Mokelumne Hill	Calaveras.
Blooming Ditch Company	Brush Creek	Butte.	Do	Red Hill	Trinity.
Blue Banks	Wolsey's Flat	Nevada.	Mammoth Bar	Auburn	Placer.
Blue Gravel	Sucker Flat	Yuba.	Manzanita	Nevada	Nevada.
Blue Point	Smartsville	Do.	Martin, Andrews & Co	Scott Bar	Siskiyou
Blue Tent	Sucker Flat	Nevada.	Maxfield & Co	do	Do.
Bonanza	Howland Flat	Sierra.	McCarthy's Diggings	Columbia Hill	Nevada.
Do	Mokelumne Hill	Calaveras.	McElroy	Angel's	Calaveras.
Borlands	Scott Bar	Placer.	McKenna	Junction City	Trinity.
Boston	Wolsey's Flat	Nevada.	Meagher & Co	Callahan's Ranch	Siskiyou.
Brown Bear	Lewiston	Trinity.	Michigan Bar	Scott Bar	Do.
Buckeye	Buckeye	Do.	Milton	French Corral	Nevada.
Bunker Hill	16 miles S. W. Happy Camp	Del Norte.	Miocene	Oroville	Butte.
Cañon Creek	Gold Run	Placer.	Moffat & Barnes	Valecito	Calaveras.
Carr	Poker Flat	Sierra.	Morning Star	Iowa Hill	Placer.
Carrol	McAdams Creek	Siskiyou.	Montezuma	Lewiston	Trinity.
Cedar Creek	Dutch Flat	Placer.	Morrison Gulch	Trinity Center	Do
Centennial	Virginia Bar	Siskiyou.	Morris Ravine	Morris Ravine	Butte.
Center Bar	Hayfork	Trinity.	Mott & Co	Oak Bar	Siskiyou.
Center Placer	Trinity Centre	Do.	Mountain View	Scott Bar	Do.
Chamberlain	Lewiston	Do.	Mu-a-mue	Happy Camp	Del Norte.
Chapman & Fisher	Arkansas Bar	Do.	Murphy	Scott Bar	Siskiyou.
Chas. Tourot	Hayfork	Do.	Nagle	Greenwood	El Dorado.
China Creek	Happy Camp	Del Norte.	Nash	Trinity Centre	Trinity.
Christmas Hill		Nevada.	Nevada	Yeo Bet	Nevada.
Claremont Peak	Claremont Hill	Plumas.	New Castle	New Castle	Placer.
Coil	Trinity Center	Trinity.	New River	Cedar Flat	Trinity.
Consolidated Amador	Pine Grove	Amador.	New York		Calaveras.
Cook's Cañon	Moonlight Mountain	Plumas.	North Bloomfield		Yuba.
Cox & Gourley	Gibsonville	Sierra.	North Fork	Seneca	Plumas.
Coyotte Gulch	Indian Creek	Siskiyou.	Oak Grove	McAdams Creek	Siskiyou.
Culver & Co	Gold Lake	Sierra.	Old Channel	Magalia	Butte.
Cunningham	Lewiston	Trinity.	Orion	Iowa Hill	Placer.
Cranage	Yankee Jim's	Placer.	Oroville	Oroville	Butte.
Dardanelles	Forest Hill	Do.	Pacific	Humbug	Siskiyou.
Davis	Sonora	Tuolumne.	Pacotolus		Yuba.
Davis & Wilson	Gold Hill	Sierra.	Paragon	Bath	Placer.
Deep Blue	Angel's	Calaveras.	Paterson	Oceta	Amador.
Del Norte	Happy Camp	Del Norte.	Pattison	Cox Bar	Trinity.
Dennerbrinks		Trinity.	Pellet & Truitt	Treka	Siskiyou.
Derbec	North Bloomfield	Nevada.	Penobscot	Mokelumne Hill	Calaveras.
Divoll	Sonora	Tuolumne.	Philip	Lewiston	Trinity.
Dry Creek	Igo	Shasta.	Pioneer	Quartz Valley	Siskiyou.
Duncan Cameron	McAdams Creek	Siskiyou.	Plumas	Quincy	Plumas.
Duryea	Mokelumne Hill	Calaveras.	Poker Bar	Hayfork	Trinity.
Eureka	do	Do.	Point Bar	do	Do.
Evans & Bartlett	Red Hill	Trinity.	Polar Star	Dutch Flat	Placer.
Excelsior	Smartsville	Yuba.	Prenkel	Scott Bar	Siskiyou.
Fort Goff Creek	Sciad Valley	Siskiyou.	Raum's	do	Do.
Franklin	Dutch Flat	Placer.	Red Hill	Magalia	Butte.
French Corral	French Corral	Nevada.	Ricci	Sweetland Creek	Nevada.
Fry Brothers	Hayfork	Trinity.	Rock Creek	Nevada	Do.
Fulton & Co	Magalia	Butte.	Rule Brothers	Weaver	Trinity.
Garden Gulch	Weaver	Trinity.	Sacka	Gold Run	Placer.
Godfrey	Grass Valley	Nevada.	Sailor Flat	Blue Tent	Nevada.
Golden Rock	Near Groveland	Tuolumne.	Saw Mill Flat		Shasta.
Gold Run	Gold Run	Placer.	Segalia		Trinity.
Good Friday	Perkins Bar	Trinity.	Shady Glen		Placer.
Gribbles		Do.	Shanghai	Alta	Trinity.
Hager & Haas	Junction City	Do.	Sheridan	Hayfork	Do.
Hancock	Scott Bar	Siskiyou.	Shoo-Fly	Perkins' Bar	Do.
Happy Camp	Happy Camp	Del Norte.	Sinclair	Trinity Center	Butte.
Happy Valley	Mokelumne Hill	Calaveras.	Siwash	Cherokee Flat	Siskiyou.
Harden	Groveland	Tuolumne.	Skunk Point	McAdams Creek	Trinity.
Hardscrabble	McAdams Creek	Siskiyou.	Slattery	Big Bar	Do.
Harvey Brothers	Weaver	Trinity.	Smartsville	Junction City	Yuba.
Hidden Treasure	Michigan Bluff	Placer.	Smith's Flat	Sucker Flat	Trinity.
Hiyou	McAdams Creek	Siskiyou.	Solas & Co	Douglas	Siskiyou.
Holmes & Green	Scott Bar	Do.	Southern Cross	Oak Bar	Placer.
Holmes & McMahon	Weaver	Trinity.	Spring Valley	Dutch Flat	Butte.
Hooper Hill	Scott Bar	Siskiyou.	Squires	Cherokee Flat	Sierra.
Hubbard & Edwards	Hayfork	Trinity.	Steep Hollow	Gibsonville	Placer.
Hungarian Hill	Quincy	Plumas.	Startovant	Dutch Flat	Trinity.
Hupp & McMurray	Weaver	Trinity.	Sucker Flat	Iowa Hill	Placer.
Independent	Iowa Hill	Placer.	Sunken Flat	Quartz Valley	Siskiyou.
Indian Cañon	do	Do.	Sunnyside	Seneca	Plumas.
Indian Bill	Gold Run	Do.	Swamp Angel	Lowell Hill	Nevada
Iron Mountain	Whisky Creek	Shasta.	Thomas	Scott Bar	Siskiyou.
Jacob	Red Hill	Trinity.	Thompson	Sciad Valley	Do.
Jacobs & Co	Scott Bar	Siskiyou.	Trinity	Taylor's Flat	Trinity.
Jacobs No. 2	Red Hill	Trinity.	Trinity C. and H. Co	Trinity Center	Do.
Johnston	Indian Creek	Do.	Truckee	Gold Lake	Sierra.
John Young	Ore Fino	Siskiyou.	Tull & Co	Quartz Valley	Siskiyou.
Junction Bar	Scott Bar	Do.	Union Consolidated	Gibsonville	Sierra.
Keefer	Angel's	Calaveras.	Union Flat	Pine Grove	Amador.
Kentuck	Brush Creek	Butte.	Union Gravel	Empire Hill	Nevada.
Kinsman & Steele	McLaughlin Bar	Siskiyou.	Union Hill	Junction City	Trinity.
Kleinman & Co	Scott Bar	Do.	Vance Bar	Big Bar	Do.

PLACER MINES—Continued.

CALIFORNIA—Continued.

Name of mine.	District.	County.	Name of mine.	District.	County.
Van Emmonds	Michigan Bluff	Placer.	Whitney & Co	Pine Grove	Amador.
Vermilion	Meridith	Butte.	Wide West	Lowell Hill	Nevada.
Virginia	Howland Flat	Sierra.	Williams	Indian Creek	Siskiyou.
Virginia Bar	Scott Bar	Siskiyou.	Wilt	Cañon Creek	Trinity.
Volcano	Pine Grove	Amador.	Wiltshire	Coz Bar	Do.
Weaver Creek	Weaver	Trinity.	Wingate	Happy Camp	Del Norte.
Weaverville	Weaverville	Do.	Wright & Fletcher	Oro Fino	Siskiyou.
Weed's Point	Gaines Hill	Yuba.	Wyandotte	Oroville	Butte.
Wheeler	June	Amador.			

COLORADO.

Alma	Alma	Park.	Oro	California	Lake.
Blue River	Bevan	Summit.	Parrot City	do	La Plata.
Cash Creek	Hope	Chaffee.	Rob Roy	Spalding	Summit.
Edward	Jackson	Clear Creek.	Sicior	Near Breckenridge	Do.
Hahn's Peak	Hahn's Peak	Routt.	Star	California	Lake.
L. H. Arthur	Grass Valley	Clear Creek.			

DAKOTA.

Battle Creek	Battle Creek	Custer.	Harmon & Rhoback	Jennie and Strawberry	Pennington.
Black Hills	Rockerville	Pennington.	Last Chance Bar	Cañon	Do.
Cañon City Bar	Cañon	Do.	McKay & Ross	Cape Horn	Lawrence.
Castle Creek	do	Do.	Stockade	Confederate	Pennington.
Fort Meade	Ruby	Do.	Swede Bar	do	Do.

GEORGIA.

Battle Branch	Twelfth	Lumpkin.	Glade	810 G. M	Hall.
Chicago and Georgia	do	Do.	Griscom	Twelfth	Lumpkin.
Cleveland and Bugge Branch	Thirteenth	Do.	Hand & Barlow	do	Do.
Cooks	Tenth	Union.	Nacoochee	Third	White.
Findley	Twelfth	Lumpkin.	Sizes	Fifteenth	Cherokee.
Forest Springs	Fourth	White.			

IDAHO.

Crepiacullia	Moore's Creek	Boisé.	R. W. Spencer	Boston	Boisé.
Hardscrabble	Elk Creek	Alturas.	Stevenson & Noble	Pioneer	Do.
Hon Ben Wilson	Pioneer	Boisé.	Thorne Creek	Moore's Creek	Do.
Noble, Lowbr & Mann	Moore's Creek	Do.			

MONTANA.

Bannock	Bannock	Beaver Head.	Oro Fino	Independence	Deer Lodge.
Butler & Anderson	Henderson Gulch	Deer Lodge.	Pioneer	Nelson	Do.
California	Thompson Gulch	Meagher.	Shoup & Blume	McClellan Gulch	Do.
Chas Pryse	McClellan Gulch	Deer Lodge.	Squaw Gulch	Gold Hill	Do.
Diamond	German	Meagher.	Tubbs & Ramsey	Thompson Creek	Meagher.
Morgan Bar	Thompson Gulch	Do.	White Bar	Bannock	Beaver Head.
Noyes & Upton	Summit Valley	Deer Lodge.	Wm. A. Cheesman	Last Chance	Lewis and Clarke.

NORTH CAROLINA.

Beaver Dam	El Dorado	Montgomery.	San Christian	Near Columbus	Montgomery.
Cochrane	Near Troy	Polk.			

OREGON.

Ah Moon	Shasta	Baker.	Forty-nine	Forty-nine	Jackson.
Anderson & McCall	Ashland	Jackson.	Fuller	Big Bend Cow Creek	Douglas.
Baisley	Pocahontas	Baker.	Gin Lin	Uniontown	Jackson.
Baisley & Daley	do	Do.	Goff, Triplet & Chapin	Grass Creek	Josephine.
Black Hawk	Near Randolph	Coos.	Grand Applegate	Applegate	Jackson.
Blue Gravel	Yank	Josephine.	Gross Brothers	Wolf creek	Do.
Borne & Lucas	Grant	Grant.	Hayes & McGruder	Sam's Valley	Do.
Boswell	Willow Creek	Baker.	Hillis	Marysville	Grant.
Campbell & Co	Shasta	Do.	Jones, Rivers & Co	Blue Cañon	Baker.
Cañon & Co	Marysville	Grant.	Josephine	Rogue River	Josephine.
Carson & Johnson	Murphy	Josephine.	Klopp & Johnson	Granite	Grant.
Catchings	Cañonville	Douglas.	Leawell & Co	Rock Creek	Do.
Chapin & Co	Uniontown	Jackson.	Lew Cooper & Co	Pocahontas	Baker.
Chas. Dwelley	Green Mountain	Douglas.	Littlefield & Duckworth	Blue Cañon	Do.
Colt & Co	Humboldt Basin	Baker.	Marysville	do	Do.
Coquille	Near Randolph	Coos.	Marshall	Coyote Creek	Jackson.
Coyote Gulch	Coyote Creek	Jackson.	McWilliams & Ash	Cañonville	Douglas.
D. A. Levens	Big Bend Cow Creek	Douglas.	Merriam & Anderson	Big Bend Cow Creek	Do.
Davenport	Forty-nine	Jackson.	Neversweat	Pocahontas	Baker.
Deep Creek	Elk Creek	Grant.	Osborne	Chicken Creek	Do.
Deselles & Co	Waldo	Josephine.	Pioneer Black Sand		Coos.
Dry Diggings	Dry Diggings	Jackson.	Porter & Co	Chicken Creek	Baker.
Dyer & Son	Green Mountain	Douglas.	Powers & Co	Rye Valley	Do.
Ericson Owens	Rock Creek	Grant.	Prairie Diggings	Marysville	Grant.
Farris Gulch	Farris Gulch	Jackson.	Rock Creek	Rock Creek	Do.
Fort Lam	Fort Lam	Do.	Rogers & Copeland	Mormon Basin	Do.

PLACER MINES—Continued.

OREGON—Continued.

Name of mine.	District.	County.	Name of mine.	District.	County.
Salmon	Big Bend Cow Creek	Douglas.	Sterling	Sterling	Jackson.
Salmon Creek	Pocahontas	Baker.	Stevenson	Shasta	Baker.
Saltmarsh & Co.	Sterling	Jackson.	Summit	Sumter	Do.
Smith	Marysville	Grant.	Thompson	Marysville	Grant.
Sproul	Cañon City	Do.	Trail Creek	Trail Run	Do.
Squaw Lake	Applegate	Jackson.	Waldo	Waldo	Josephine.
Steam Beer	Grass Creek	Josephine.	Wickaiser & Co.	Oaksco	Wasco.
Steiger's French Gulch	Shasta	Baker.	William Rubie	Coyote Creek	Jackson.

SOUTH CAROLINA.

Brewer		Chesterfield.			

UTAH.

Argonaut	West Mountain	Salt Lake.			

WASHINGTON.

Cañon Creek	Skagit	Whatcom.	Swauk Creek	Swauk	Yakima.
Ruby Creek	do	Do.			

DITCHES.

ALABAMA.

Name of line.	District.	County.	Name of line.	District.	County.
Idaho		Clay.			

ARIZONA.

Boston	Greenlee Gold Mountain	Apache.	Vulture Pipe Line		Maricopa.
Jackson		Yavapai.			

MONTANA.

Bannock	Bannock	Beaver Head.	Pioneer and Keystone	Nelson	Deer Lodge.
Birch Creek	Thompson Gulch	Meagher.	Rock Creek	Squaw Gulch	Do.
Camas	do	Do.	Smart's Creek	Henderson Gulch	Do.
Diamond	German	Do.	White Bar	Bannock	Beaver Head.
Hall Columbia	Independence	Deer Lodge.	William A. Chessman	Last Chance	Lewis and Clarke.
John Noyes	Summit Valley	Do.			

IDAHO.

Alderson	Moore's Creek	Boisé.	Lisco	Elk Creek	Alturas.
Christy	do	Do.	Mountain	Moore's Creek	Boisé.
Crepiscella	do	Do.	Plowman	do	Do.
Cuddy	do	Do.	Spencer	Boston	Do.
Dunn	do	Do.	Stevenson & Noble	Pioneer	Do.
East Moore's Creek	do	Do.	Thorn Creek	Moore's Creek	Do.
Hanson	do	Do.	Upper Alderson	do	Do.
Lambing	do	Do.	Wilson	Pioneer	Do.

GEORGIA.

Anticiola and Etowah	Fourth	Dawson.	Hand	Twelfth	Lumpkin.
Cocsa Creek	Tenth	Union.	Nacoochee	Third	White.
Dahlonega	Twelfth	Lumpkin.	Singleton	Twelfth	Lumpkin.
Glade	do	Hall.	Town Creek	Fourth	White.

DAKOTA.

Battle Creek	Battle Creek	Custer.	Last Chance	Cañon	Pennington.
Black Hills C. & W. Co	Whitewood	Lawrence.	McKay & Ross	Cape Horn	Lawrence.
Black Hills Placer Co.	Rockville	Pennington.	Stockade	Confederate	Do.

COLORADO.

Alma	Alma	Park.	Stelor		Summit.
Boston		Summit.	Star	California	Lake.
Elk River	Hahn's Peak	Routt.	Stevens & Leiter	do	Do.
Gold Run		Summit.	Union-French		Summit.

DITCHES—Continued.

OREGON.

Name of line.	District.	County.	Name of line.	District.	County.
Anderson & McCall	Ashland	Jackson.	Jones & Carpenter	Pocahontas	Baker.
Ashland	Forty-nine	Do.	Josephine		Josephine.
Baisley	Pocahontas	Baker.	Klopp & Johnson	Granite	Grant.
Blue Gravel	Gant	Josephine.	Lake	Rock Creek	Do.
Borne & Lucas	Granite	Grant.	Low Cooper & Co	Pocahontas	Baker.
Carson & Johnson	Murphy	Josephine.	Littlehall & Duckworth	Blue Canon	Do.
Catchings	Canonville	Douglas.	Marshall	Coyote Creek	Jackson.
Chapel & Co	Uniontown	Jackson.	Marysville	Blue Canon	Baker.
Charles Dwelley	Green Mountain	Douglas.	McWilliams & Ash	Canonville	Douglas.
Colt & Co	Humboldt	Baker.	Merriam & Anderson	Big Bend Cow Creek	Do.
D. A. Levens	Big Bend Cow Creek	Douglas.	Miner's	Marysville	Grant.
D. F. Salmon	do	Do.	Nelson	Pocahontas	Baker.
Deep Creek	Elk Creek	Grant.	Pioneer		Coos.
Deseelles & Co	Waldo	Josephine.	Placer Gold	Clarksville	Baker.
Dyer & Son	Green Mountain	Douglas.	Powers & Co	Rye Valley	Do.
El Dorado	Shasta	Baker.	Prairie Diggings	Marysville	Grant.
Farris Gulch	Farris Gulch	Jackson.	Rock Creek	Rock Creek	Do.
Forty-nine	Forty-nine	Do.	Saltmarsh & Co	Sterling	Jackson.
Gin Lin	Uniontown	Do.	Squaw Lake	Applegate	Do.
Goff, Triplett & Chapin	Grass Creek	Josephine.	Steam Beer	Grass Creek	Josephine.
Grand Applegate	Applegate	Jackson.	Sterling	Sterling	Jackson.
Gross Brothers	Wolf Creek	Do.	Thompson	Marysville	Grant.
Hayes & McGruder	Sam's Valley	Do.	W. Boswell	Willow Creek	Baker.
Hillis	Marysville	Grant.	W. Rush	Coyote Creek	Jackson.
Humboldt	Canon City	Do.	Waldo	Waldo	Josephine.
J. B. Gardner	Granite	Do.	Wicksizer & Co	Ochoco	Wasco.
J. G. Fuller	Big Bend Cow Creek	Douglas.	Weifinger	Canon City	Grant.
J. N. Osborne	Chicken Creek	Baker.	Young & Rinehol	Sumter	Baker.

INDEX TO PRECIOUS METALS.

A.

Page.

Accidents in deep mines 176-177
Accidents in placer mines 204
Accidents to ditches 226-230
Accounts in San Francisco mint, system of 269
Ada county, Idaho 82, 86
Adjusting room, Carson mint 261
Adjusting room, San Francisco mint 266
Advance in mining industry in past decade xii
Agitators in amalgamating mills 267
Air compressors and blowers or fans 151
Alabama, arrastras 321, 327
Alabama, deep mines, directory 511
Alabama, deep mines, means of handling water 142
Alabama, deep mines, supplies, cost, and consumption 160-161, 170, 172
Alabama, ditches, cost of plant 211
Alabama, ditches, directory 531
Alabama, ditches, grade and dimensions 223
Alabama, ditches, plant of 206
Alabama, fumes 199
Alabama, length of water season 215-216, 219
Alabama, product of precious metals 344, 345, 354-360
Alabama, product of precious metals in deep mines 344-345, 348, 349, 354
Alabama, stamp batteries 243
Alaska, product of precious metals 358, 358, 369
Alpine county, California 76
Altitude of mining districts 106-130
Altitude of placer mines 178-180
Altitude of shafts of the Comstock mine 111
Alturas county, Idaho 84, 86, 87
Amalgam caught in battery 257
Amalgam distributed in sluices 196-200
Amalgam, retorting of 260
Amalgamating mills 243-265
Amalgamating mills, directory 524-527
Amador county, California 9, 10, 16-17
American Fork district, Utah 444-445
American Journal of Science cited 16, 27
American ownership of deep mines 111
Analysis of soil, Golden, Colorado 61
Ancient fluvial system, California 180-181
Animas district, Colorado 93
Annealing room, Carson mint 260
Annealing room, San Francisco mint 266
Antelope district, Utah 475
Antimony mines in Utah 483
Apache county, Arizona 47
Applegate district, Oregon 39
Arapahoe county, Colorado 94, 330
Arizona, amalgamating mills 260, 262, 524
Arizona, arrastras 321, 327
Arizona, deep mines, directory 511-513
Arizona, deep mines, means of handling water 142
Arizona, deep mines, supplies, cost, and consumption 160-161, 170, 172
Arizona, ditches, cost of plant 211
Arizona, ditches, directory 531

Page.

Arizona, ditches, grade and dimensions of 223
Arizona, ditches, plant of 206
Arizona, fumes 199
Arizona, mineral belt 5
Arizona, geological sketch of 44-52
Arizona, length of water season 215, 219
Arizona, placer directory 529
Arizona, product of precious metals 339-340, 354
Arizona, product of precious metals in deep mines 350-351
Arizona, roasting furnaces 279
Arizona, smelter directory 569
Arizona, stamp batteries 240
Arizona, steam hoisting engines 136, 139
Arizona, transportation of precious metals through Wells, Fargo & Co.'s Express 366, 371
Arrastras 320-327, 527-529
Artesian wells, Colorado 91-92
Arts, precious metals used in 376
Ashbrook district, Utah 434
Assay of ore 269
Assay office, receipts at 376-379
Assay plant, Carson mint 260
Assay value of fine bullion 261
Assayer's department, Carson mint 262-263
Assayer's department, San Francisco mint 450
Auriferous gravel deposits, sections of 13-14
Auriferous gravels 11, 17, 21, 35
"Auriferous gravels" of Professor Whitney quoted 16, 30, 47, 201
Auriferous sands, Oregon and Washington 37
Austin, Nevada 32
Average product of gold and silver per square mile and per capita 350

B.

Baker county, Oregon 37, 39
Baker's Park, Colorado 92
Banner district, Idaho 87
Barney's Cañon mines, Utah 476
Basalt 27, 191
Batteries, stamp 237-253
Bay Horse district, Idaho 84
Bear Butte district, Dakota 97, 98
Bear Gulch mines, Utah 412-413
Bear Lake county, Idaho 89
Beaver county, Utah 41, 482-476
Beaver Head county, Montana 96, 97, 100
Beaver Lake district, Utah 476
Becker, George F. 9, 1, 2
Becker, George F., geological sketch of the Pacific division 5-52
Bedrock of pliocene 133, 139
Bell or gong as mine signal 142, 143
Bent county, Colorado 94
Berg- und hüttenmännische Zeitung cited 266
Bevan district, Colorado 72
Big Cottonwood district, Utah 397-399
Bingham cañon, Utah 402-411
Bingham gold placers, Utah 413-420

	Page.
Bitumen in California	9, 18, 24, 25, 26
Blast engines at Leadville	288
Black Hills, Dakota, geological sketch of	89-94
Blake, W. P., cited on ores	5-49
Blake, W. P., estimate of gold exported from San Francisco	380
Blasting in placers	189
Blind Spring district, California	21
Blowers or fans, distribution of	151
Blue Ledge district, Utah	443
Boilers, Carson mint	393
Boilers, deep mines	153-154
Boisé basin, Idaho, sale of water	55-56, 238, 241
Boisé county, Idaho	52, 56, 57-58
Bonanza defined	30
Borax	34
Bonneville lake studied by G. K. Gilbert	38, 39
Boulder county, Colorado	64-68
Boulder district, Utah	415
Bowie, Aug. J., jr., feed pipes	232-233
Bowie, Aug. J., jr., miner's inch	240
Box Elder county, Utah	483-485
Bracket flumes	231
Bradshaw district, Utah	474-475
British Columbia, shipments of bullion through Wells, Fargo & Co.'s express	370, 371
Brückner furnace	269, 272, 273, 274, 275
Bullion, assay value of fine	361-365
Bullion from retorts	267, 269
Bullion product, Colorado	335
Bullion product, Leadville	293
Bullion product, United States by states	356-357
Bullion product, world, annual	361
Bullion product, Utah	407
Bullion, San Francisco mint	401
Bullion, tax on, in Nevada	312
Bullion, tenor of, amalgamating mills	247
Bullion, transportation of	366-373
Burchard, Hon. H. C., estimate of bullion product	377
Burnt River district, Oregon	27
Butte county, California	13, 17

C.

	Page.
Cables, hoisting	134-138
Calaveras county, California	17
California, amalgamating mills, directory	524-525
California, amalgamating mills, plant	259, 262
California, arrastras	281, 527
California, auriferous gravels	10
California, conflict between hydraulic mining and agricultural interests	203
California, deep mines directory	512-513
California, deep mines, means of handling water	143
California, deep mines, supplies, cost and consumption	160-161, 170, 172
California district, Colorado	77
California ditches, cost of plant	211-212
California ditches, plant of	206-207, 209, 210
California ditches, grade and dimensions	223
California flumes	228-230
California, feed-pipes in hydraulic mines	190, 233-234
California, geological sketch of	7-26
California, length of water season	216-217, 219
California, placer directory	529-530
California, product of precious metals	299-306
California, product of precious metals in deep mines	350, 352, 354, 356, 358, 360
California, reservoirs	235
California, roasting-furnaces	270
California, sale of water	238
California, smelter directory	528
California, stamp batteries	248-249, 251, 252, 253, 254, 255
California, steam hoisting engines	126, 127, 128
California, transportation of bullion through Wells, Fargo & Co.'s express	366-368, 371
California, tunnels in placer mines	187-188
Cameron, J. C., beehive charcoal furnace	471
Camp Floyd district, Utah	454-455
Cañon Creek district, California	26
Capital stock of deep mines	114
Capital stock of leading hydraulic mines	185
Capital stock of water companies	205
Caribou district, Colorado	65, 67
Carson district, Idaho	52, 54
Carson mint	383-396
Cassia county, Idaho	59
Castle Dome district, Arizona	52
Castle Valley coal-field, Utah	483
Caswell, J. H., on eruptive rocks of Black Hills	90, 91
Cedar City coal mining, Utah	480
Cedar Valley district, Arizona	49
Centerville, California	17
Central district, Colorado	65, 67
Cerro Gordo district, California	19
Chaffee county, Colorado	79
Chalk Creek district, Colorado	70
Charcoal burning, Utah	471
Chemicals used in amalgamation	264-265
Cherokee district, California	13, 17, 22
Chili mills, Carson mint	394
Chimneys in placer mines	188
Chinese charged higher water rates	238
Churchill county, Nevada	34
Cicott, Frank X., coiner at San Francisco	398, 399
Cinnabar	10, 15, 16, 23, 24, 26, 27-28, 455
Clackamas county, Oregon	23
Clark county, California	23
Classification of mines	296
Classification of reduction works	296
Clayton, Prof. J. E., on Utah coal-fields	483
Clear Creek county, Colorado	70-72
Clifton district, Utah	455, 456
Coinage at Carson mint	395
Coinage, amount of	376
Coiner's department, Carson mint	389-392
Coiner's department, San Francisco mint	398-400
Coining presses, Carson mint	392
Coins, weight	393
Coke at Leadville	289
Colfax county, New Mexico	101
Colfax district, California	23
Coal, Arizona	44
Coal, California	16, 58
Coal, Colorado	68
Coal, Idaho	59
Coal, Oregon	27
Coal, Washington territory	27
Coal, Wyoming	27
Coal-fields in Utah	485-489
Coalville district, Utah	485-487
Coast range, mineral deposits	7
Colorado, amalgamating mills	260, 262, 525
Colorado, arrastras	281, 527
Colorado, deep mines, directory	513-515
Colorado, deep mines, means of handling water	143-144, 149
Colorado, deep mines, supplies, cost, and consumption	163-165, 170, 172
Colorado, ditches, cost of plant	223
Colorado, ditches, directory of	531
Colorado, ditches, grade and dimensions	224
Colorado, ditches, plant of	207
Colorado, flumes	230
Colorado, feed-pipes in hydraulic mines	191, 234
Colorado, geological sketch of	60-86
Colorado, length of water season	217, 219
Colorado, ore raised in census year	320-322
Colorado, placer mine directory	530
Colorado, product of precious metals	354, 360
Colorado, product of precious metals in deep mines	354-355
Colorado, roasting furnaces	271
Colorado, sale of water	238
Colorado, smelter directory	528
Colorado, stamp batteries	249, 251, 255
Colorado, steam hoisting engines	127-128, 129
Colorado, tunnels in placer mines	188
Columbia district, Utah	455
Colusa county, California	20

Pages.

Comparative production of precious metals 368-380
Comparative summary of results xii
Comstock amalgamating mills, men employed 244-245
Comstock amalgamating mills, wages 244
Comstock lode, the 31
Comstock lode, transportation of bullion through Wells, Fargo & Co.'s express 371
Comstock mines, altitude of shafts 111
Comstock mines, hoisting cables 136
Comstock mines, length of drifts, cross-cuts, shafts, inclines, and winzes 124, 125
Comstock mines, men employed 158, 159
Comstock mines, production of 312
Comstock mines, supplies, cost and consumption 173
Comstock, T. B., on geology of San Juan county, Colorado 83
Concentration works 415, 423, 436, 441
Construction of arrastras 282
Consumption and wear in batteries 257
Consumption of precious metals in the arts 376
Consumption of supplies 169-173
Cook district, Utah 446
Coos county, Oregon 28
Copper, California 14
Copper, Colorado 334
Copper, Utah 419, 420, 463, 471
Copper, Wyoming 88
Copper used in minting 357, 382
Copperopolis, California 14
Cordilleras 44
Cornish clappers as mine signals 142
Cornish pumping rigs 147-151
Coso district, California 19
Cost of drift mining 203-204
Cost of hydraulic mining 201-202
Cost of labor and material, Leadville 294-295
Cost of plant, arrastras 282
Cost of plant, deep mines 154-155
Cost of plant, mining ditches 211-214
Cost of supplies, Carson mint 396
Cost of treatment in amalgamating mills 246-247
Criticism of results xi
Cross district, Dakota 91, 93
Crucibles 267, 385
Cummings, Henry, cited 464
Curtis, J. S., aid in report 1, 3
Custer county, Colorado 80-81
Custer county, Dakota 91, 94
Cutting room, Carson mint 390

D.

Dakota, amalgamating mills, directory 525
Dakota, amalgamating mills, plant 260
Dakota, deep mines, directory 515
Dakota, deep mines, means of handling water 144
Dakota, deep mines, supplies, cost, and consumption 184-185, 170, 172
Dakota, ditches, cost of plant 212
Dakota, ditches, directory 531
Dakota, ditches, grade and dimensions 224
Dakota, ditches, plant 207
Dakota, flumes 230
Dakota, feed-pipes in hydraulic mines 191, 234
Dakota, geological sketch of 89-94
Dakota, length of water season 217, 219
Dakota, placer directory 530
Dakota, placer tunnels 188
Dakota, product of precious metals 354-360
Dakota, product of precious metals, deep mines 336-337
Dakota, roasting furnaces 271
Dakota, scarcity of water 228
Dakota, smelter directory 538
Dakota, stamp batteries 249
Dakota, steam hoisting engines 128, 130
Dakota, tunnels in placer mines 186
Deep mines 165-177
Deep mines, directory 511-524
Deer Lodge county, Montana 96-97, 96
Del Mar, A., statistics cited 297, 307-313, 38

Pages.

Del Norte county, California 17
Depth of workings in deep mines, maximum 123-124
Deseret district, Utah 455
Detroit district, Utah 462
Development of deep mines 121
Devereux, W. B., cited on geology of Black Hills 89-94
Diamonds in placers 184
Dimensions of mining ditches 223
Dimensions of some long tunnels of the world 125
Dimensions of specimen flumes 229
Directory of deep mines, amalgamating mills, arrastras, smelting works, placer mines, and ditches 509-532
Disposition of bullion, amalgamating mills 247
Distribution of gold and amalgam in sluices 196
Ditches, mining 205-241
Ditches, mining, directory 531-532
Division of the Rocky mountains, statistics 330-343
Doña Ana county, New Mexico 102
Douglas City district, California 26
Douglas county, Colorado 79
Douglas county, Oregon 27, 28
Dooly, J. E., furnished statistics 318, 319
Drags in arrastras 282
Drapersville district, Utah 431
Drills, power 151, 189
Drops in sluices 197
Dry-crushing 247
Dry Lake district, California 23
Dugway district, Utah 460
Dumps in hydraulic mining 187
Duration of ditch-lines 237
Dust-chambers 274, 297, 298
Dutton, C. E 44

E.

Earnings, Carson mint 396
Earnings, San Francisco mint 402
Eastern division, product 358
Eastern division, personnel of 2
Eastern division, statistics of 343-359
East Lake district, California 19
Eckfelt, John A., inventor of clipping-machine 267
Elbert county, Colorado 64
El Dorado county, California 18
Elk Horn district, Utah 449
Elk Mountain district, Colorado 78
Elko county, Nevada 34
El Paso county, Colorado 79
Emma mine, Utah 423-427
Emmons, S. F. ..... v, 1-3, 30, 32, 33, 55
Emmons, S. F., geological sketch of the Rocky Mountain division 60-104
Emmons, S. F., lead-smelting at Leadville, Colorado 286-296
Emmons, S. F., statistics of the division of the Rocky mountains 330-343
Endlich, F. M., cited 67, 80, 82, 83
Engineer's and mechanic's pocket book cited on miner's inch 239
Engineering and Mining Journal cited 40
Engines at Carson mint 394
Engines, miscellaneous 152
Engines, steam hoisting 127-133
Esmeralda county, Nevada 34, 35
Eureka county, Nevada 35
Eureka district, Nevada 32-34
Evaporation from mining ditches 230
Expenditures at Carson mint 395, 396
Expenditures at San Francisco mint 402
Experts, employed 1-3
Experts, instructions to 491-508
Exploration of the 40th parallel, cited 5, 31, 82, 106
Exploration of the 40th parallel, quoted 30, 31, 32
Exploration west of the 100th meridian, cited 447, 449, 453
Exportation of gold from San Francisco, estimated 380
Extent of workings in deep mines 122

F.

Fans 151
Feed-pipes in hydraulic mines 189-192, 232-235
Filter for fine dust 269

	Page.
Fire-brick making	436
Fish springs, California	19
Flagstaff smelter	435
Flint Creek district, Montana	97
Flue-dust	274-275, 294, 300
Flumes	227-232
Fluxes at amalgamating mills	267
Fluxes at Leadville	289
Fluxes at mints	395, 397
Force employed in amalgamating mills	243-245
Force employed in Comstock mines, 1880	158
Free Gold district, Colorado	79
Fremont, J. C	29
Fremont county, Colorado	80
Fremont Island district, Utah	484
Fresno county, California	18
Fuel at amalgamating mills	274
Fuel at Leadville	289
Furnaces at amalgamating mills	267
Furnaces at Leadville	286-288
Furnaces, roasting, in amalgamation	269-276

G.

Gabb, W. M., on California	7, 8
Garnets in placers	184
Gas explosion in amalgamating pans	265-266
Gauge boxes	241
General smelting operations, Leadville	291-292
Genesee Valley district, California	22
Genth, F. A., cited	66, 67, 488
Geological sketch of Arizona	44-52
Geological sketch of California	7-26
Geological sketch of Colorado	80-86
Geological sketch of Idaho	52-59
Geological sketch of Montana	86-100
Geological sketch of Nevada	29-38
Geological sketch of New Mexico	100-104
Geological sketch of Oregon and Washington	27-29
Geological sketch of the Black Hills of Dakota	89-94
Geological sketch of the Pacific division	5-59
Geological sketch of the Rocky Mountain division	60-104
Geological sketch of the San Juan region	82
Geological sketch of Utah	38-44
Geological sketch of Wyoming	96-89
Geological survey of California cited	8, 9, 16
Geology of placer mines	180-184
Geology of Eureka district, quoted	32, 33
Georgia, amalgamating mills	525
Georgia, deep mines, directory	515
Georgia, deep mines, means of handling water	144, 149
Georgia, deep mines, supplies, cost	164, 165, 170, 172
Georgia, ditches, cost of plant	212
Georgia, ditches, directory	531
Georgia, ditches, grade and dimensions	234
Georgia, ditches, plant of	207
Georgia, length of water season	217, 219
Georgia, placer directory	550
Georgia, product of precious metals	344-360
Georgia, product of precious metals, deep mines	344, 348, 354
Georgia, stamp batteries	249
Georgia, tunnels in placer mines	188
Germania Smelting and Refining Company	431
Gilbert, G. K., cited	38, 45, 46, 100
Glaciers, Sierra	12
Globe district, Arizona	48, 51
Gold and copper belt, California	5
Gold and silver bullion, Carson mint	395
Gold and silver bullion, San Francisco mint	401
Gold and quicksilver lost in hydraulic mining	200
Gold and silver coins, size and weight	392
Gold and silver minting	383-392
Gold and silver bullion, assay value	361-366
Gold belt, California	9
Gold deposited at mints	374-375
Gold distributed in the sluices	196-200

	Page.
Gold exports from San Francisco, 1848 to 1883, estimated	330
Gold, geological occurrence of	9, 10, 11, 16
Gold Hill district, Colorado	67, 68
Gold in placers, occurrence of	182
Gold, Oregon	27
Gold placers of Bingham, Utah	419-430
Gold product of Southern states, estimated, 1804 to 1850	330
Gold, Utah (*see, also*, Utah, geological sketch)	419-430
Gold veins	10
Gold, Wyoming	87
Gordon mining district, Utah	462
Grabill, L. R., on Custer county deposits	81
Grade and dimensions of mining ditches	223-226
Grade and dimensions of specimen flumes	229-230
Grand county, Colorado	64
Grand Island district, Colorado	65
Granite. (*See* Geological sketches.)	
Granite district, Utah	475
Granite Mountain district, Utah	455
Grant county, Oregon	28
Grant county, New Mexico	103-104
Grantville district, Utah	455
Grass-root gold	183
Grass valley, California	22
Grave Creek district, Oregon	29
Gravel deposits, geological relations	180-184
Gravel deposits, Montana	340
Gravel mills	204
Gravel mining, sections	12-14
Gravels, auriferous	17
Great Basin	29, 38
Great Salt lake	484-485
Greely district, Utah	455
Gregory district, Colorado	69, 70
Grinding in amalgamation	263-264
Grizzlies	197
Guerneville, California	25
Gunnison county, Colorado	77-78
Guyard, A., report on smelting at Leadville (*see* Leadville)	3, 286

H.

Hague, Arnold, geology of Eureka district	32, 33
Hague, J. D., on mining	xiii
Hague, J. D., on mining industry	105, 240, 262
Harrisburg district, Utah	477-483
Haswell, C. H., on miner's inch	229
Hayden hill, California	20
Heating pans, method of	262, 263
Hills, R. C., on San Juan ore deposits	82
Hinsdale county, Colorado	86
Historical summary, Utah	406
Hoisting cables	134-138
Hoisting engines	127-133, 439
Hoisting, mode of	139-140
Holmes, W. H., on geology of Elk mountains	78
Homer district, California	21
Homestake district, Colorado	77
Homestake stamp mills	279-280
Hooker, W. A., on Horn Silver mine	464-468
Horn Silver mine	40, 464-470
Horn Silver smelter	436
Hot Springs district, Utah	431
Howell, E. E., on New Mexico	100
Howell, E. E., on Utah	41, 447, 488
Howell furnace	269, 272, 273, 274, 275
Hualapai district, Arizona	48, 49
Huerfano county, Colorado	81
Humboldt county, California	13
Humboldt county, Nevada	35, 36
Humbug district, California	14
Huntley, D. B., report on Utah	2, 3, 41, 468-480
Hydraulic mines, product	337, 340, 350
Hydraulic mines, sections	13, 56
Hydraulic mining	187-203
Hydraulic nozzles	193-196

I.

Page.

Idaho, amalgamating mills ... 525
Idaho, arrastras ... 261, 284-285, 527
Idaho, arrastras, directory ... 526
Idaho county, Idaho ... 58
Idaho, deep mines, directory ... 515-517
Idaho, deep mines, means of handling water ... 144
Idaho, deep mines, supplies, cost and consumption ... 164-165, 170, 172
Idaho, ditches, cost of plant ... 213
Idaho, ditches, directory of ... 531
Idaho, ditches, grade and dimensions ... 224
Idaho, ditches, plant ... 207
Idaho, flumes ... 230
Idaho, geological sketch of ... 52-59
Idaho, length of water season ... 217-219
Idaho, placer directory ... 530
Idaho, placer gold ... 351, 352, 353
Idaho, product of precious metals ... 323-326
Idaho, product of precious metals in deep mines ... 324-325
Idaho, roasting furnaces ... 271
Idaho, smelter directory ... 528
Idaho, transportation of bullion through Wells, Fargo & Co.'s express ... 369, 371
Iddings, J. P., cited ... 90
Inch, the miner's ... 230-241
Indian district, California ... 21
Indian Creek district, California ... 25, 26
Indian Valley district, California ... 22
Ingot melting room, Carson mint ... 388
Ingot melting room, San Francisco mint ... 397
Instructions to experts ... 491-508
Introductory remarks ... vii-xiv
Investigation, methods of ... x
Investigation, scope of ... x
Investment and ownership, placers ... 184-186
Inyo county, California ... 18-19
Iowa Hill district, California ... 13
Iron county, Utah ... 476-477, 480
Iron Mountain district, California ... 24
Iron, occurrence of, California ... 23
Iron ore, Oregon ... 27
Iron Springs district, Colorado ... 84, 85
Iron Springs iron mining district, Utah ... 476
Iron used in amalgamating ... 265

J.

Jackson county, Oregon ... 27, 28
Jamestown, California ... 26
Jamestown, Colorado ... 66
Jefferson county, Colorado ... 62
Jefferson county, Montana ... 96, 97, 99
Jenney, W. P., on geology of Black Hills ... 89-94
Jet in Colorado ... 62
Josephine county, Oregon ... 27, 29
Juab county, Utah ... 43, 456-461

K.

Kane county coal, Utah ... 489
Kearsarge district, California ... 19
Kern county, California ... 19
King, Clarence, cited on geology ... v, 1, 2, 5, 27, 30
King county coal, Oregon ... 28
Kootenai county, Idaho ... 59

L.

Labor and material, cost of, Leadville ... 294
Labor and wages, deep mines ... 156-157
Labor in amalgamating mills ... 345
Labor in arrastras ... 283
La Grange district, California ... 13
Lake Bonneville ... 38, 39
Lake county, California ... 19
Lake county, Colorado ... 76-77
Lakeside district, Utah ... 455, 456
Lander county, Nevada ... 36
La Plata county, Colorado ... 85
Larimer county, Colorado ... 64
Las Animas county, Colorado ... 64

Page.

Lassen county, California ... 20
Last Chance district, Montana ... 98
Lava ... 27, 52, 181
Lawrence county, Dakota ... 92-93
Le Conte, J., cited ... 16
Leaching works ... 415
Lead, geological relations ... 6
Lead product, Colorado ... 334
Lead smelting, Leadville ... 286-295
Lead, Utah ... 406, 430, 433
Leading, a cause of sickness ... 438
Leadville, Colorado ... 63, 76-77
Leadville, Colorado, lead smelting ... 286-295
Leakage in mining ditches ... 220
Lemhi county, Idaho ... 58
Length of water season, mining ditches ... 216-219
Lesquereux, L., on ancient climate ... 13
Lewis and Clarke county, Montana ... 96, 97, 99
Lignite, California ... 16
Lincoln county, Nevada ... 36
Lincoln county, New Mexico ... 102
Lincoln district, Utah ... 475
Lines of uplift and ore belts ... 5, 6
Lining of ditches ... 226-227
Little Cottonwood district, Utah ... 422
Lookout district, California ... 19
Los Angeles county, California ... 20
Loss in melting and refining, Carson mint ... 393
Loss in melting at mints ... 385
Loss of gold and quicksilver in sluicing ... 200
Loss of quicksilver in amalgamating mills ... 265
Lucin district, Utah ... 484
Lyon county, Nevada ... 37

M.

McAdams Creek district, California ... 14, 25
McClellan Gulch district, Montana ... 96, 98
McGarry district, Utah ... 475
McKay district, Colorado ... 78
Mackintosh, J. B., analyzed Utah ores ... 41
Madison county, Montana ... 96, 97, 99
Magnolia district, Colorado ... 65, 67, 68
Maine, amalgamating mills ... 526
Maine, deep mines, directory ... 517
Maine, deep mines, means of handling water ... 145, 149
Maine, deep mines, supplies, cost and consumption ... 164, 165, 171, 172
Maine, roasting furnaces ... 271
Maine, stamp batteries ... 249
Marble district, Utah ... 443
Marble in Utah ... 471
Marcou, Jules, cited on geology ... 40, 100
Maricopa county, Arizona ... 43
Mariposa county, California ... 20
Materials, cost, at Leadville ... 294
Mattes, Leadville ... 290
Maynard district, Arizona ... 48, 49
Means of handling water in deep mines ... 143-147
Mechanismus der Gebirgsbildung, cited ... 30
Melter and refiner's department, Carson mint ... 385-389
Melter and refiner's department, San Francisco mint ... 396-400
Mendell, Lieutenant-Colonel, on hydraulic mining ... 184-185, 208, 219, 235
Mendocino county, California ... 26
Merced county, California ... 26
Metacinnabarite ... 15
Metamorphic gold belt, California ... 9
Methods of investigation ... xi
Mexico, transportation of bullion through Wells, Fargo & Co.'s express ... 370, 37
Michigan Bluffs, California ... 13
Middle Boisé district, Idaho ... 54
Millard county, Utah ... 461-462
Mill Creek district, Utah ... 433
Milling-machines, Carson mint ... 392
Mills, amalgamating ... 243-285
Minerals of Boulder county, Colorado ... 66-67
Minerals of Clear Creek county, Colorado ... 70-71
Minerals of Custer county, Colorado ... 81

Page.

Minerals of El Paso county, Colorado 79
Minerals of Gilpin county, Colorado 69
Minerals of Lake county, Colorado 77
Miner's inch 239-241
Mines by altitudes 110
Mines, deep 166-177
Mines, deep, directory 511-524
Mingo Furnace Company 431-433
"Mining débris in California rivers", cited 184, 219
Mining districts with average altitudes 106-109
Mining districts of Summit county, Colorado 72
Mining ditches 205-241
Mining industries of Utah 463-480
Mint, Carson 383-396
Mint, San Francisco 396-402
Minting of gold and silver 383-402
Mode of hoisting in deep mines 139-140
Mints, receipts at 374-375
Mode of signaling in mines 141-142
Mokelumne Hill district, California 17
Monographs United States Geological Survey, cited 30, 31, 125
Monarch district, Colorado 79
Mono county, California 21
Montana, amalgamating mills 260, 526
Montana, arrastras 281, 527
Montana, deep mines, directory 517
Montana, deep mines, means of handling water 145
Montana, deep mines, supplies, cost and consumption 165-167, 171, 172
Montana, ditches, cost of plant 213
Montana, ditches, directory 531
Montana, ditches, grade and dimensions 225
Montana, ditches, plant 209
Montana, flumes 231
Montana, geological sketch of 94-100
Montana, length of water season 218, 219
Montana, placer directory 530
Montana, product of precious metals 337-340
Montana, product of precious metals in deep mines 338-339
Montana, roasting furnaces 271
Montana, smelter directory 528
Montana, stamp batteries 249-250
Montana, tunnels in placer mining 188
Morgan Mining and Smelting Company 433-435
Morgan county, Utah 483
Morris Ravine district, California 13
Mount Baldy district, Utah 483
Mount Estes district, Idaho 58
Mount Nebo district, Utah 480
Mountain belt, Colorado 62
Mullett, A. B., architect of Carson mint 383
Murchison, Sir R., on geological relations of gold 9

N.

Napa county, California 20-21
Nationality of Comstock mill men 345
Nebraska, smelter directory 528
Nevada, amalgamating mills 243, 260, 526
Nevada, arrastras 281, 527
Nevada city, California 22
Nevada county, California 21-22
Nevada, deep mines, directory 517-520
Nevada, deep mines, means of handling water 145-146, 147
Nevada, deep mines, supplies, cost and consumption 166-167, 171, 172
Nevada district, Colorado 69-70
Nevada, geological sketch of 29-38
Nevada, product of precious metals 354-360
Nevada, product of precious metals in deep mines 354-355
Nevada, roasting furnaces 271
Nevada, stamp batteries 250
Nevada, transportation of bullion through Wells, Fargo & Co.'s express 369, 371
New Almaden quicksilver mines 15
New Eldorado district, Utah 481
New Hampshire, deep mines, directory 530
New Hampshire, product of precious metals 346, 348
New Mexico, amalgamating mills 261, 526
New Mexico, arrastras 281, 527
New Mexico, deep mines, directory 521
New Mexico, deep mines, means of handling water 146
New Mexico, deep mines, supplies, cost and consumption 166-167, 171, 172
New Mexico, geological sketch of 100-104
New Mexico, product of precious metals 354-360
New Mexico, product of precious metals in deep mines 355-356
New York, transportation of bullion through Wells, Fargo & Co.'s express 370-371
Newberry, J. S., cited 12, 38, 39, 40, 41, 44, 109, 476-477, 478
Newfoundland district, Utah 484
Newton Forks district, Dakota 91, 94
Newton, Henry, on geology of Black Hills 89-94
Nez Percé county, Idaho 59
Nichol's concentrating works 436
North Carolina, amalgamating mills 261, 526
North Carolina, arrastras 282, 527
North Carolina, deep mines, directory 521
North Carolina, deep mines, means of handling water 146
North Carolina, deep mines, supplies, cost and consumption 166-169, 171, 172
North Carolina, placer directory 530
North Carolina, product of precious metals 346, 360
North Carolina, product of precious metals in deep mines 354-355
North Carolina, roasting furnaces 272
North Carolina, stamp batteries 250
North Star district, Utah 472
Nozzles at hydraulic mines 193-196
Nye county, Nevada 37

O.

Oasis district, Utah 455
Oak Hill district, California 21
Ocoeho district, Oregon 29
O'Harra furnace, The 269, 273, 278
Ohio district, Utah 462
Omaha Smelting and Refining Company 434
Oneida county, Idaho 59
Ontario silver stamp mill 276-279
Ophir mining district, Utah 450-451
Oquirrh range, Utah 407
Ore belts and lines of uplift 5, 6
Ore assays, amalgamating mills 269
Ore raised in Colorado 330-332
Ore deposits, Colorado 66, 80-83
Ore treated in amalgamating mills 242
Ore deposits, Black Hills, Dakota 91-92
Ore deposits, Montana 95-96
Oregon, amalgamating mills 261, 526
Oregon, arrastras 282, 526
Oregon, deep mines, directory 521
Oregon, deep mines, product 327
Oregon, deep mines, supplies, cost and consumption 168, 169, 171, 172
Oregon, ditches, cost of plant 213
Oregon, ditches, directory 532
Oregon, ditches, plant 208-209
Oregon, geological sketch of 27-29
Oregon, placer directory 530-531
Oregon, product of precious metals 327-329
Oregon, roasting furnaces 273
Oregon, sale of water 239
Oregon, transportation of bullion through Wells, Fargo & Co.'s express 369-370, 371
Oregon, tunnels in placer mines 188
Ores, Leadville 288-289
Ores, San Juan region 82-83
Oro Fino district, California 26
Osceola district, Utah 455
Ouray county, Colorado 84-85
Owen's district, Arizona 49-50
Ownership of arrastras 282
Ownership of deep mines 211, 213
Ownership of placers 184-186
Owyhee county, Idaho 58

P.

Pacific division, geological sketch 5-39
Pacific division, personnel of 1

	Page.
Pacific division, product of precious metals	358
Pacific division, statistics of	320-329
Pacific express, bullion from Utah by	372
Pan amalgamation	258-262
Panamint district, California	19
Pans for working ore	262
Park county, Colorado	74-76
Parks defined	62
Paul, A. B., arrastras	782
Payson district, Utah	446
Payson, Lieutenant, cited	210
Pearce, Richard, cited	69
Peckham, S. F., examined California coal	16
Peculiar conditions affecting American mines	vii
Pennington county, Dakota	91, 98
Personnel, Carson mint	396
Personnel, deep mines	156
Personnel, division of the Rocky mountains	2
Personnel of the Eastern division	2
Personnel of the Pacific division	1
Personnel, San Francisco mint	402
Peoharton district	29
Petermann's Mittheilungen cited on bullion produced	376
Petroleum in Wyoming	88
Pfaff, F., cited	30
Pi Ute county, Utah	462-464
Pima county, Arizona	49
Pinal county, Arizona	51
Pine Grove district, Utah	471
Pilts furnace	266
Pinecate district, California	23
Pinto county, Utah	42
Pinto iron-mining district, Utah	476-477
Pioneer district, Arizona	51
Pioneer sampling mill	437
Placer county, California	22
Placer deposits, Dakota Black Hills	92
Placer deposits, Colorado	75-76
Placer deposits, Montana	96
Placer gold, specimen examples	350-362
Placer gold, average tenor	352-353
Placer mines	173-241
Placer mines, directory	529-531
Placer mines, product	334, 337, 340, 342
Placerville, California	18
Plant, assay, Carson mint	396
Plant of arrastras	262
Plant of deep mines, cost	154-155
Plant of lead-smelting at Leadville	286-288
Plant of amalgamating mills	258-262
Plant of mining ditches	206-215
Platinum in placers	182-184
Pleasant Valley coal mines, Utah	467-468
Pliocene rivers, California	12
Plumas county, California	22
Pocahontas district, Oregon	28
Poole, H. S., coal analysis	488
Position and altitude of mining districts	106-120, 123, 124
Position of placer mines relative to supplies	178
Potter, Colonel C., killed	102, 341
Potter Ridge district, California	18
Powell, J. W., cited	2, 90, 94
Power arrastras	262
Power drills	151
Power, Carson mint	396
Press-room, Carson mint	392
Press-room, San Francisco mint	390
Preuss district, Utah	471
Process in arrastras	262
Product of bullion of United States for year ending May 31, 1880	326-327
Production of deep mines for the year ending May 31, 1880	354-355
Production of precious metals	296-302
Profits in hydraulic mining	202
Provo district, Utah	445
Pumpelly, Prof. Raphael, statistics of the eastern division	343-350
Pumps	143-151, 401, 446

Q.

	Page.
Quantity of water delivered by mining ditches	220-222
Quartz valley, California	25
Quicksilver belt	5
Quicksilver lost in sluices	260
Quicksilver ore	15, 16, 25, 27-28
Quicksilver used in amalgamation	258-264

R.

Rank of the states and territories in production of the precious metals	360
Raschette furnace	266
Raymond, R. W., estimate of bullion	377-380
Reasons for incompleteness	xi
Receipts at mints and assay offices	374-375
Red Hill district, California	26
Reduction works, classification of	298
Reducibility of various ores	246-247
Refinery, Carson mint	396
Refinery, San Francisco mint	396-397
Relation of labor to product in amalgamating mills	245
Repairs on ditches	226-227
Reports of the United States geological exploration of the 40th parallel, cited	5, 31, 32, 80, 94, 106, 262, 408, 422, 485, 487
Reports on geology and resources of the Black Hills of Dakota, cited	89-94
Reservoirs in California	235
Retorting of amalgam	260
Retorts	267
Reverberatory furnace	269, 272, 273, 274, 276
Rio Grande county, Colorado	86
Rio Grande valley, New Mexico	109
Riffles	198
Roasting furnaces	269-276
Rock salt in Utah	461
Rock-breakers in mills	255
Rockford district, Dakota	91, 98
Rocky district, Utah	474
Rocky mountains, division of the	2
Rocky Mountain division, geology	80-104
Rocky Mountain division, product	358
Rocky Mountain division, statistics	330-343
Rogers, A. N., cited	60
Rosebud district, Utah	484
Rothwell, R. P., on Silver Reef mines	478
Routt county, Colorado	64
Rubies in placers	184
Ruby Hill district	33
Rush Valley district, Utah	447-450
Russ district, California	19
Russell district, Colorado	69-70
Rusty gold in placers	183

S.

Sacramento and San Joaquin basin, water used	219
Sacramento county, California	23
Saguache county, Colorado	86
Saint Vrain creek, Colorado	64-65
Sale of water	237-241
Salivation	268
Salt	23, 461, 477, 485
Salt Lake county, Utah	42-43, 467-488
Saltpeter in Utah	461
Salt used in roasting	274
Sampling mills, Salt Lake	431, 437
San Bernardino county, California	23
San Carlos, California	18
Sandberger, F., cited	54
San Diego county	23
Sands, auriferous sea	27
Sandy sampling mills	437
San Francisco custom-house, movement of treasure through	372-373
San Francisco district, Utah	464-471
San Francisco mint	382, 396-402
San Francisco stock board, list of mining stocks	114-120
Sangre de Cristo range	80-81, 86
San Joaquin basin, water used	219
San Juan county, Colorado	83-84

	Page.
San Juan region	92-96
San Luis Obispo county, California	23
San Pete county, Utah	435-436
San Simeon, California	23
Santa Barbara county, California	24
Santa Clara county, California	24
Santa Clara district, Utah	433
Santa Fé county, New Mexico	103
Santaquin district, Utah	446
Saturn smelter	435
Saw Buck district, Utah	463
Sawyer's Bar, California	25
Scales, assay, Carson mint	302, 304
Scales & Wagner's arrastra mill	265-266
Schedules, mining	496-506
School of Mines Quarterly, cited	12
Sciad valley, California	25
Scope of the investigation	x
Sebastopol district, California	20
Second annual report of the Director of the United States Geological Survey, cited	32, 38, 39
Sections of auriferous gravel deposits	13-14
Seneca district, California	22
Sevier county, Utah	461
Sevier Lake district, Utah	462
Shaler, Professor N. S	2
Shasta county, Oregon	28
Sheppard, C. M., cited	67
Shipments of bullion, dust, and amalgam through Wells, Fargo & Co.'s express	366-372
Shifts, length of	262
Shoshone county, Idaho	59
Sierra county, California	24
Sierra, Nevada	6, 7, 12, 27
Signaling in deep mines, mode of	141-142
Silliman, Professor B. F., enumeration of placer minerals	187
Silliman, Professor B. F., on New Mexico	103
Silverado, California	20
Silver Bow county, Montana	96-97
Silver bullion, assay value	301-306
Silver bullion, Carson mint	295
Silver bullion, San Francisco mint	401
Silver coins, size and weight	302
Silver creek, Oregon	28
Silver district, Arizona	53
Silver in placer gold	350
Silver in Wyoming	87
Silver Islet district, Utah	494
Silver Lake district, Utah	445
Silver minting	363-402
Silver mountain, California	23
Silver product estimated by A. Del Mar	361
Silver Reef district, Utah	477
Silver used at mints	334, 374-375
Silver veins	10
Simundi, A	54
Siskiyou county, California	25
Slag, Leadville	223
Sluices	197
Smelters near Salt Lake city	431-436
Smelting works, Arapahoe county, Colorado	332
Smelting works, directory	328
Smelting works, product, Utah	317, 318
Smith, Hamilton, jr., on water for mining	235, 240
Smith, J. Alden, on minerals	67, 69
Snake Creek district, Utah	442-443
Sneffles district, Colorado	84, 85
Socorro county, New Mexico	102
Soda sulphates in Wyoming	88
Soetbeer, Dr. A., estimate of bullion product	376-377
Soil analysis, Golden	61
Solfataras	6, 53
Sonoma county, California	25
Source of water for mining	216
South Carolina, amalgamating mills	526
South Carolina, placer directory	531
South Carolina, product	348, 349, 350
Spaniards worked New Mexico mines	102
Spanish Fork district, Utah	446
Specimen examples of placer gold	351-352
Spelss	294, 434
Stamp batteries	247-258
Stanislaus county, California	25
Star districts, Utah	471-474
Statistics of the division of the Rocky mountains	320-343
Statistics of the eastern division	343-350
Steam hoisting engines	127-133
Sterling district, Utah	471
Stetefeldt furnace	269, 272, 273, 274, 275
Stevens smelter	435-436
Stevenson, J. J., on New Mexico	100
Stocks of deep mines dealt in at the San Francisco boards at close of census year	114-120
Storey county, Nevada	57
Strainers	266
Stream tin	154
Sugar Loaf district, Colorado	67
Sulphur	274, 462
Sulphurets, per cent. of, in gold ores	268
Sulphuric acid process, San Francisco mint	397
Summit county, Colorado	72-74
Summit county, Utah	438-442
Summit county, Utah, coal district	485-487
Summit district, Colorado	86
Summit Valley district, Montana	96
Sunshine district, Colorado	67
Supplies, deep mines, their cost and consumption	160-173
Surveys west of 100th meridian, cited	40, 41
Sutro tunnel, the basis of altitudes	111
Sweetwater county, Wyoming	89
Systematic geology of King, cited on Oregon	27

T.

Tailings	267, 268, 269
Tanks, settling	258
Taxed product of the Nevada mines	312-313
Tehama county, California	26
Ten-mile district, Colorado	73
Tenor of bullion, amalgamating mills	247
Tenor of ore treated in arrastras	263
Tenor of placer gold	352-353
Third annual report director United States Geological Survey, cited	30
Thurston county, Oregon	28
Tin	124
Tinstone	55, 59
Tintic district, Utah	456-461
Titles in deep mines	113
Titles in placer mines	186
Tooele county, Utah	447-456
Transactions of American Institute of Mining Engineers, cited	31-33, 100, 182, 201
Transactions of American Institute of Mining Engineers, on miners' inch	240
Transportation of bullion	366-373
Treasure movement through San Francisco custom-house	372-373
Tunnel sites	426-427
Tunnels, placer	187-188
Tunnels, table of long, in the world	125
Tuscarora, Nevada	34

U.

Uintah district, Utah	438-442
Uintah range. (*See* Utah.)	
Uncompahgre district, Colorado	83, 84
United States Mining Commissioners' report, cited	436
United States mint, Carson	293-296
United States mint, San Francisco	396-402
Utah, amalgamating mills	527
Utah, coal	485-489
Utah county, Utah	44, 444-446
Utah, deep mines, directory	521-524
Utah, deep mines, means of handling water	147
Utah, deep mines, supplies, cost and consumption	168-172

Page.

Utah, geological sketch 36-44
Utah, mining industries 462-490
Utah, placer directory 561
Utah, product of precious metals 312-319
Utah, product of precious metals in deep mines 314-315
Utah, roasting furnaces 272
Utah, smelter directory 528
Utah, stamp batteries 260-262
Utah, transportation of bullion through Pacific express 372
Utah, transportation of bullion through Wells, Fargo & Co.'s express .. 370, 371

V.

Valentine, J. J., estimate of bullion 277, 278-280
Ventura county, California 26
Virginia, amalgamating mills 527
Virginia, deep mines, directory 524
Virginia, deep mines, means of handling water 147
Virginia, deep mines, supplies, cost and consumption 167-172
Virginia, product of precious metals 346-349
Virginia, product of precious metals in deep mines 354-355

W.

Wages, amalgamating mills 243-244
Wages, Comstock mines 159
Wages, deep mines 156, 157
Wages, ditch labor 227
Waldeser, C., on hydraulic apparatus 187
Walker, Francis A., committed mining investigations to Clarence King .. 1
Ward district, Colorado 97
Warm Springs smelting works 496
Wasatch county, Utah 442-444, 495
Wasatch range. (*See* Utah.)
Wasco county, Oregon 27
Washington county, Idaho 52, 59
Washington county, Utah 477-483
Washington district, Utah 471
Washington territory, arrastras 533
Washington territory, deep mines, directory 534
Washington territory, deep mines, supplies, cost and consumption 171, 172
Washington territory, geological sketch of 27-30
Washington territory, placer mines, directory 581
Washington territory, product of precious metals 339, 354-360
Washington territory, products of precious metals in deep mines 354-355

Page.

Washoe district, Nevada 31
Water for mining, sources of 215
Water, means of handling in deep mines 143-151
Water, sale of 337-341
Water season, length of 200, 216-219
Wear and consumption in batteries 237
Weber county, Utah 483
Weld county, Colorado 64
Wells, Fargo & Co.'s express, shipments of precious metals through 368-371
Wells, Fargo & Co.'s statement of the mineral product of Utah for 1879. 318-319
West Mountain district, Utah 407-427
West Star district, Utah 473
West Tintic district, Utah 460
Wet-crushing 247
Whatcom county, Oregon 27
Wheeler's, Geo. M., surveys 44, 96, 100, 499
Whims and whips 194
Whisky creek, California 24
White furnace 269, 272, 273, 275
White Pine county, Nevada 38
Whitefield, Professor R. P., on fossils of San Juan region 82
Whitney, Professor J. D., data collected by 7-11, 30, 389
Williams, Albert, jr 2, 3, 55
Williams, Albert, jr., the mining of gold and silver 393-402
Willard district, Utah 483
Wire stays for flumes 228
Wood river region, Idaho 55
Wolters, cited 55
World annual bullion product 381
Wyoming, amalgamating mills 527
Wyoming, deep mines, directory 524
Wyoming, deep mines, means of handling water 147
Wyoming, geological sketch of 86-89
Wyoming, product of precious metals 342-360
Wyoming, product of precious metals in deep mines 342-348, 354-355

Y.

Yakima county, Oregon 29
Yank district, Oregon 29
Yankee Fork district, Idaho 58
Yavapai county, Arizona 51
Yuba county, California 24
Yuma county, Arizona 53